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The Geographical Journal

Vol. LX No. 5 November 1922

THE TOPOGRAPHICAL WORK OF THE OXFORD UNIVERSITY EXPEDITION TO SPITSBERGEN (1921) *

R. A. Frazer

Read at the Meeting of the Society, 22 June 1922.

THE Oxford University Expedition of 1921 was initially an ornithological enterprise, but was rapidly enlarged to embrace a range of interests, so diverse that the party had to be organized in two independent sections.

The programme of the first section entailed visits to bird-breeding grounds at proper seasons. During the months of June and July this section, under the leadership of the Rev. F. C. R. Jourdain, visited Bear Island and cruised up the west coast of Spitsbergen in their sloop the *Ternigen*. A party of five landed on Prince Charles Foreland and remained for some ten days, engaged principally in geology, whilst the bird party continued their cruise northwards as far as Moffen Island and Liefde Bay. They returned down the west coast towards the end of July.

The second section, under the leadership of Mr. N. E. Odell, comprised a sledge party detailed for topographical work, and a base party engaged on various studies in the Klaas Billen Bay area. Of the results obtained by the expedition only those of topographical interest will be dealt with in the present paper.

History of the Area.—The region investigated by the sledge party was the tract of country referred to by Sir Martin Conway as "Garwoodland." Extending north-east of Ice Fjord, and bounded towards the north by the Chydenius range, the region constitutes the geographical centre of the Spitsbergen archipelago.

From the west a natural approach is by the Nordenskiöld glacier, which curves down from the north and terminates in a westerly direction on the waters of Klaas Billen Bay. This glacier was thoroughly explored by Baron G. De Geer in 1882 and the subsequent years; detail surveys of the coast area have also been carried out by Mr. John Mathieson, of the Scottish Spitsbergen Syndicate. The interior was probably first viewed from the east by Baron A. E. Nordenskiöld in 1864 from the summits of

* To be reprinted as 'Results of the Oxford University Expedition to Spitsbergen,' No. 13.

Mount Edlund and White Mountain, which he had ascended from Stor Fjord (Wybe Jans Water). Until Sir Martin Conway's and Prof. Garwood's pioneer sledge journey of 1897, however, no expedition had been extended far inland. The following notes refer to work in the interior, and should be read in relation to Sir Martin Conway's 'With Ski and Sledge over Arctic Glaciers' (Dent, 1898); his paper in *Geogr. Four.*, 12, p. 137, with map, gives a briefer account.

In 1899 Baron De Geer ascended Svanberg, also from Stor Fjord (*Geogr. Four.*, 17, p. 434). During the years 1898–1902 a combined Russo-Swedish expedition accomplished the measurement of an arc of meridian in Spitsbergen, but certain of the topographical results have remained unpublished, and may now be regarded as lost (see also *Geogr. Four.*, 58, p. 35). Two relevant memoirs by Helge Backlund are, however, available, dealing with the geology and glaciology of the interior ('Miss. Scient. pour la Mesure d'un Arc de Méridien au Spitzberg,' Tome II. Sect. ix. B. 1 and B. 2). The latter paper contains an incomplete map, incorporating a photogrammetric survey of the Klaas Billen Bay area by Baron De Geer, a topographical survey of the Svanberg group carried out in 1901 by Captain Siegel, and a sketch survey, admitted to be of inferior accuracy, of the Mount Newton group. These surveys have been supplemented by results obtained by Mr. Mathieson and by the Oxford University Expedition, in the map illustrating the present paper. In July 1900 a Russian party travelled up the glacier between Mounts Terrier and Ferrier, and thence northwards to Chydenius, where a primary triangulation beacon was erected on Mount Chernishev (Tschernyschew), one of the four peaks of Mount Newton: a return was made by the same route. In August 1901 a party under A. S. Vassilyev travelled from Stor Fjord to Mount Backlund, and thence northwards to Mount Chernishev, where theodolite observations were undertaken. A survey party also journeyed between Klaas Billen Bay and Stor Fjord over Svanberg. These routes are shown, with others, on the small-scale map accompanying Wichmann's paper in *Petermanns Mitteilungen* for 1910, which gives a brief but complete summary of work to that date in the interior of Spitsbergen.

In 1913 Captain Staxrud led a daring relief party to the aid of the German expedition frozen in at Treurenberg Bay ('Die Expeditionen zur Rettung von Schröder-Stranz und seinen Begleitern,' D. Reimer, Berlin, 1914), but the speed at which the party travelled precluded any attempt at mapping. The outgoing route was up the Post glacier and through a pass to the east-north-east, whence the main ice-parting was gained and followed northwards to New Friesland. On the return a party travelled from Bismarck Strait across the Negri glacier and back to Temple Bay. Until the year 1921 no other visits appear to have been paid to the area under consideration.

Despite these explorations our Admiralty chart still retains the legend

"inland ice" written across the regions north-east of Ice Fjord. In 1897 the interior was proved to be a glaciated mountain and valley system with true watersheds, the mountains constituting the remains of a denuded plateau. The glaciological observations by Backlund in 1889, 1900, and 1901 confirm the view that inland ice, in the sense of an expanse of ice so thick as to mask all irregularities of the subsoil, does not exist in this area, although circumscribed tracts are described where the ice conditions are qualitatively, but not quantitatively, comparable with those in Greenland. These questions are fully discussed in the original memoirs.

The term "inland ice" is now regarded as obsolete, and on the basis of Mr. Priestley's classification* the so-called central ice-plateau of Garwoodland is "highland ice," defined as "a thin but continuous ice-sheet, with the upper surface conforming to a considerable extent to the major irregularities of the land on which it rests." With regard to the complex eastern drainage system of the "highland ice," mention need only be made of the vast unnamed glacier which flows from the highest dome in the ice divide south of Chydenius. The first reference made to this glacier is the following passage from Sir Martin Conway's 'With Ski and Sledge over Arctic Glaciers,' p. 38: "We were standing at the head of a broad snow-white valley, to which a long slope drooped from our feet. On either side the valley was enclosed by faces of rock, bluff fronts cut out of what was formerly a big plateau, level with our position. The glacier itself swept away in its wide dignified fashion, first east, then gradually in a great curve to the south-east, on its slow crawl towards Wybe Jans Water." Backlund mentions a glacier, probably identical with the above, although the descriptions do not correspond absolutely (*Miss. Sc.*, Tome II. ix. B. 2, p. 22). From the ice divide the Russian party descended towards the north-east in a large "depression," which offered to the east-north-east a passage to Hinlopen Strait through a "wide white valley" cutting into a plateau formed of horizontal Triassic deposits compared to those near Stor Fjord. In the map accompanying Backlund's paper the upper reaches of the white valley are indicated, but neither the country to its immediate south, separating it from the Svanberg group, nor the outlying topography towards Hinlopen Strait are depicted.

The sledge journey of the Oxford Expedition was intended to cover some of the omissions in that map. In the accomplishment of this project we were only partially successful; the exploration was extended south of the white valley, and in a certain measure eastwards, but much remains to be done. A particular problem awaiting solution is the exact point of outlet of the great white valley—to be found, probably, opposite Cape Torell ('The First Crossing of Spitsbergen,' p. 348). Owing to the uncertain accuracy of the northern portion of the original map, considerable difficulty has arisen in combining the different surveys, and the map submitted can only be viewed as provisional and subject to revision.

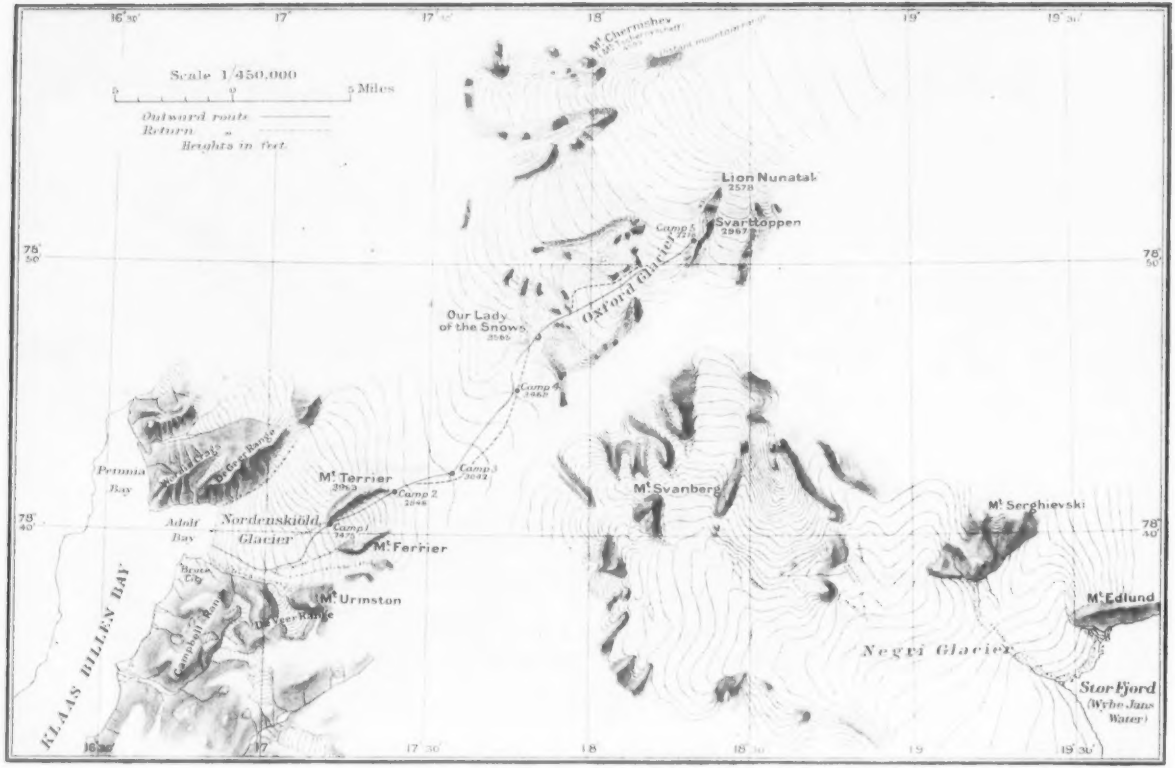
* Still unpublished.

The 1921 Expedition. Preparatory Work in Base Area.—Of the nine members forming the second section, four were already in Spitsbergen at the time of our departure from England. The remainder left Newcastle on July 2, and after a voyage beset with unforeseen and exasperating shipping complications, reached base quarters at the head of Klaas Billen Bay at midnight on July 21, some nine days late on programme. The generous hospitality of the Scottish Spitsbergen Syndicate enabled us to use for base quarters the commodious huts at Bruce City, a mile from the front of the Nordenskiöld glacier.

Our section comprised the following members:—*Sledge Party:* N. E. Odell (leader and geologist); T. G. Longstaff (medical officer and naturalist); R. F. Stobart and R. A. Frazer (surveyors). *Base Party:* A. M. Carr-Saunders (marine zoology); C. S. Elton (bacteriology); R. N. Segnit (geology); G. Slater (glaciology); J. Walton (botany). Of those who were already quartered at Bruce City on our arrival, three had been cruising with the first section. The fourth, Stobart, had been stationed with the Scottish Spitsbergen Syndicate in Gips Valley, occupied with stores and survey duties. His activities, however, had been seriously hampered by blood poisoning; and after a period in Longyear hospital he had proceeded to Bruce City, to be joined there by Longstaff.

During the remaining days of July the surveyors established a theodolite triangulation from a base-line previously measured and utilized by Mr. Mathieson. Stobart, who was responsible for the readings of the 4-inch theodolite, rendered invaluable assistance, often under conditions which, in view of his indisposition, must have proved extremely trying. Our instruments included four Negretti and Zambra thermometers, a Kew pattern mercury barometer, a Watkin and a smaller aneroid, and a Johannsen chronometer watch, all of which were calibrated, before and after our travels, at the National Physical Laboratory. On the sledge journey both a half-plate and a panoramic camera were taken, photogrammetric methods being employed for rapidity.

As a result of Stobart's illness, it unexpectedly devolved upon Odell and Longstaff to undertake the preparation and packing of stores for the sledge journey, practically *ab initio*. Two "polar" sledges, of length 9 feet, were used, supplied by Messrs. Hagen of Christiania. Spare metal runners were also ordered; of these, one pair failed to reach Spitsbergen, and the other proved to be a misfit for both sledges. After dismantling one of the sledges, Odell succeeded in fitting the metal runners, which were later found markedly superior to the wooden ones. For haulage, sledge harness of Shackleton type was employed, provided with a 6-foot strap and a toggle, which latter could, in cases of emergency, be rapidly unthreaded from a loop at the end of the haulage rope. According to the conditions of travel the lengths of the haulage ropes varied from 6 to 20 feet. Special mention should be made of the extremely efficient Burberry overall suits, weighing about 2½ pounds per



SKETCH-MAP TO ILLUSTRATE THE WORK OF THE OXFORD UNIVERSITY SPITSBERGEN EXPEDITION, 1921

The work is adjusted to Mounts Chernishev and Svanberg, fixed by the Russo-Swedish Geodetic Survey. Heights by theodolite on coast and aneroid inland. Detail of Nordenskiöld glacier from surveys by Mr. John Matthieson and Baron de Geer; of Negri glacier by Capt. Siegel (1901); of Oxford glacier partly from sketch by Russo-Swedish Expedition.

suit; the addition of large pockets would, however, have proved a convenience under the conditions experienced.

Ascent of Mount Terrier and Reconnaissance to the High Interior.—On a reconnaissance inland, carried out on July 26, a party, consisting of Odell, Longstaff, and Segnit, ascended the southern bank of the Nordenskiöld glacier for 4 miles, to the limestone moraine heaps on a small tributary glacier descending between Mounts Cadell and Urmston. From this point a diagonal course across the Nordenskiöld glacier brought the party, after some adventures with crevasses and water-logged snow, to the moraine skirting the south-east flank of Mount Terrier. A relatively simple route was now made to the south-west summit of the nunatak, over very steep screes, largely composed of fallen limestone blocks. The prolific Cyathophyllum Limestone Series of the Carboniferous System extends to the summit, and many fossil corals were found. A notable feature also was the abundance of surface polygons or *rute* marks, so familiar to travellers in the Arctic. Theodolite triangulation subsequently gave the height of the south-west peak above sea-level as 3544 feet, in close agreement with the value from aneroid observations taken by the reconnaissance party.

Although a commanding view-point in other respects, the south-west peak proved of little value for inspection of outlying country to the north-east. Clouds were coming up rapidly, and the party hurried to reach the higher north-east summit, about 1 mile distant. Owing to lightly crusted snow, progress became excessively laborious, and the summit was reached only just before mist obscured the view. Between clearings, some features of distant ranges could be distinguished, but the definition was too poor for successful photography. This summit is the highest point of Mount Terrier, and consists of a rounded and indefinite ice dome, a circumstance which may account for the want of agreement between altitudes as quoted on various maps. Intersected theodolite sights on a conspicuous mark from a number of stations gave the height as 3963 feet; an isolated aneroid observation furnished a figure higher by 68 feet.

An earlier ascent of the north-east peak, by a route on the "northern" face of the mountain, was made in July 1905 by a mountaineering party, consisting of A. Hacker, Dr. Freiherr von Saar, and H. Sattler (*Zeitschrift des D.O.A.-V.*, Band 40, 1909, pp. 109 *et seq.*). Inspection from a neighbouring peak, probably Mount Urmston, led this party to infer that the approach to the easy "southern" face was impracticable at the time, owing to the difficult ice conditions at the border of the glacier; in 1921 the passage from the glacier was easy. Marked crevassing at the base of the nunatak appears also to have been observed in the summer of 1900 by Backlund, on his way from the west coast to the interior of Spitsbergen (*loc. cit.*).

Our own party descended by the eastern ridge, which merges into the snow slopes from the edge of the so-called ice plateau. They then proceeded in a southerly direction along the plateau, in order to erect a

inland. Detail of Nordenskiöld glacier partly from sketch by Russo-Swedish Expedition.

survey mark, and subsequently descended over crusted snow to intermittent moraine patches below the south-east flank of Mount Terrier. Beyond this point the return route can be identified with the course to be described in connection with the inland journey. Bruce City was regained after a march of twenty-four hours.

An important result of this preliminary expedition was the establishment of a route to the ice plateau suitable for the sledges. The need for mobility, however, impressed itself acutely, because our time inland, already too limited, promised to be further curtailed. In order to meet certain requirements of the Scottish Spitsbergen Syndicate, who had guaranteed our return passage to Longyear City, it had become incumbent upon us to regain our base from inland on or before August 25, the date announced for departure of the sloop for Norway. It was therefore decided to forego the northerly route laid down originally in our sledging programme, and to substitute a north-easterly course, which promised to prove more profitable in the short time available. The sledge party, moreover, was reduced to three members only, organized to travel as a unit for the greater part of the distance with a single sledge. Shortly before the date fixed for departure, Stobart unfortunately had a serious relapse, and the party finally comprised Odell, Longstaff, and the writer.

Towards the end of July the sledges and the bulk of the stores were conveyed by boat to the foot of the Nordenskiöld glacier. In view of the steepness of the lower reaches of the glacier and the prevalence of stones and grit, it was decided to economize the sledge-runners by porterage of a proportion of the load for the first few miles. Owing to assistance given by the base party this relay work was sufficiently advanced by August 4 to allow of our leaving one sledge with a large depôt of stores at the foot of Mount Terrier.

The Sledge Journey. Route to the Main Divide.—The weather, which had remained fair since our arrival, now much deteriorated, and it was with some misgivings that we assembled in drizzle on August 7 at the foot of the glacier to pack outstanding stores. For the first 4 miles we followed one or other side of the moraine which descends from Mount Ferrier. Over this initial section the surface was either grit and stones or else excessively hummocked ice, and both categories proved objectionable. After passing a derelict sledge we reached a conspicuous conical mound of stones, situated at an altitude of 1021 feet, above which the moraine was lost in the intricacies of an icefall. A sloping course northwards past a maze of crevasses led to the intermittent Mount Terrier moraine, where the general gradient and its attendant difficulties moderated. As we approached Mount Terrier the grey clouds began to dissipate, and we rattled down the final incline to our depôt over sparkling honeycombs of ice and set up camp. At an average rate of a mile per hour, the march had brought us 6½ miles inland to an altitude of 1475 feet.

In connection with the moraines of the Nordenskiöld glacier, Backlund observes that the one from Mount Terrier consists entirely of angular blocks, but that the Mount Terrier moraine, as noted also by Prof. Garwood, comprises rounded blocks and débris. Both were examined by Odell, and found to contain an appreciable admixture of angular blocks of Carboniferous limestone and of Archæan formation. At the foot of Mount Terrier the morainic material could be differentiated into rounded blocks coming from the north side of the nunatak and into angular blocks and fragments, both of Archæan and limestone, coming from the south side. The angular Archæan fragments were obviously derived from a large Archæan outcrop which was passed later along the south flank of Mount Terrier. Prof. Garwood attributed the polished rocks to an ancient or "fossil" moraine belonging to an early period of glaciation (*Quart. Journ. Geolog. Society*, November 1899, vol. 55); but Backlund traces their origin to a small glacier which descends from the summit of Mount Terrier and deposits its "moraine profonde" as a "rampart" on the main glacier. The drainage of the glacial lake at the foot of the nunatak is also noteworthy in that the waters now escape through a short ice gorge, and tunnel into the glacier in order to obtain outlet; the chaotic ice conditions observed in 1897 were not in evidence, and the lake appears to have shrunk considerably.

After a day devoted to survey, the sorting of stores, and the very laborious transport of the wooden-runnered sledge—with about one-half of the total load—towards the ice plateau, we struck camp. A route was taken out on the glacier parallel and close to the south-east flank of Mount Terrier. At about 2000 feet the dry glacier disappeared, and the surface became crusted snow, on which crampons still proved serviceable. Extreme caution was necessary here, owing to the recurrence of wide snow-covered crevasses, which were difficult to detect under the prevailing light-conditions.

Before the final steep rise of 500 feet to the plateau, further progress with the full load became impracticable. The south-east face of Mount Terrier here loses its somewhat monotonous aspect, the intrusion of pink and grey granite in Archæan rock resulting in the formation of a deep-cut corrie, whose accumulated waters discharge from a ravine, and, after collecting to form a small lake, escape by a stream along the edge of the glacier. The outcrop of the Archæan is one of the most notable on this face of the mountain, and consists of great columnar bastions of variously tinted rock. Farther east the crags merged into a steep ice-cliff, overhung by a snow cornice, which latter evidently represented the upper termination of the formidable slope we were about to negotiate.

After laying a depôt we continued with one lightened sledge, and, passing the foot of the ice cliff, soon found ourselves struggling knee-deep in soft snow, lying at an angle of 19°. Above the snow cornice an unpleasant obstacle presented itself in the form of a typical "schrund," or

large crevasse, fringed with soft snow to a depth of several feet, and somewhat scantily bridged at one point only. We took the precaution here to excavate deep corridors in the snow to serve as approaches to the bridge, before bringing the sledge across at a rush. Running conditions then improved, and a final traverse over practically level ground led to the edge of the ice plateau. Camp was set up at an altitude of 2846 feet, some distance below the lowest rock outcrops of the eastern ridge of Mount Terrier.

Recovery of the second sledge was deferred, and advantage taken of unusually good visibility to continue the survey and to reconnoitre in an east-north-easterly direction. After an advance of about 2 miles, a long line of hills was sighted bordering the far side of the plateau, and extending roughly along the meridian. Distance, however, could not be estimated with any hope of success, owing to the deceptive clearness of the atmosphere and to lack of feature in the intervening wastes of snow. To our east the range culminated in Mount Svanberg, beyond which, through a notable gap, the waters of Stor Fjord could be seen blending delicately with sky blues and the shades of Edge and Barent's Islands. Towards the north-easterly quarter the rock peaks gradually lost character, and were eventually replaced by rounded snow summits, although the extent to which these persisted could not be ascertained, owing to interference of rising ground close ahead. Bordering Wijde Bay, however, countless peaks were dazzling in bright sunlight, supplementing an already too deeply engrossing panorama.

During the morning of August 10 we set out in mist and drizzle to bring up the second sledge and remaining stores. An improved route was found more towards the centre of the glacier, the maximum inclination amounting to only 11 degrees; trouble with crevasses, which had been anticipated on the previous day, did not materialize. Later, a cairn for the survey was erected on a rock shelf below the north-east summit of Mount Terrier at an altitude of 3418 feet. As seen from this view-point the east face of Mount Terrier is impressively wild, and consists of a terraced amphitheatre of yellowish limestone, capped by a ferocious ice cliff, which cuts into the summit dome of the mountain. Arctic fulmars, fluttering from their nesting-places in the cliffs, emphasized the general air of disorder brought about by constant avalanches. On the ridge Odell noted two large blocks of pink granite, whose presence in the limestone zone showed them to be erratic boulders derived from some Archæan outcrop to the north, and deposited when the level of the ice plateau was at least 1000 feet higher than it is at present. This case supports previous evidence of marked ice wastage since the last period of maximum glaciation in Spitsbergen.

On August 11 we struck out on ski with a single sledge loaded to 500 lbs. over the soft snow of the plateau. After rounding the head of the glacier basin on the north side of Mount Terrier, we followed without

KLAAS BILLEN BAY

THE NORDENSKIÖLD GLACIER

VIEW FROM CAMP I.: ROUTE TO THE ICE PLATEAU

DE GEER'S RANGE FROM CAMP I.

difficulty a north-easterly course at a gentle upward gradient, until well abreast of the point reached on our recent reconnaissance. Here according to programme a third camp was set up (3042 feet), in order to establish the survey and decide on the best point at which to attack the range across the plateau.

Of two inviting lines of advance, the first, through the prominent gap to the south of Mount Svanberg, was evidently that already followed to Stor Fjord by Russian surveying parties. A second possible weakness was, however, disclosed to the north-east, over a low glacier pass, behind which, through the telescope, some small rock outcrops were just discernible. This north-easterly pass, shown by rough triangulation to be some 8 miles distant, was selected as our next objective.

Rain and thick fog delayed our further advance until the morning of August 13; meanwhile the camp had grown exceedingly wet and displeasing, and we yearned for those desirable regions described by Backlund where farinaceous snows are the sole form of atmospheric precipitation (*Miss. Sc.*, Tome II. ix. B. 2, p. 5). At first the newly hardened snow conduced to rapid progress, but a thaw revived more familiar conditions, and we soon found ourselves obliged to steer laboriously by compass through thick fog, with Odell directing the course from the rear. For at least one of the party the mental discomforts of this monotonous march were enhanced by a broken ski-binding, which constantly encouraged left-handed deviations from course and adverse criticism from the navigator. After about 5 miles the rapidly increasing gradient forced us temporarily towards the north, where the slope was still sufficiently trying. A long struggle brought us to the summit of a snow saddle, seamed longitudinally by a pair of treacherous crevasses, which prompted an immediate halt. Not ungrateful for the excuse, we left the sledge and set out on a carefully steered course in search of some definite landmark. An hour later a loom showed vaguely ahead, and soon resolved itself into the north-east pass, less than a mile distant.

Elated, we retraced our tracks and engineered the sledge over the two crevasses and across the deep laborious snow of southerly slopes to the foot of the pass. Welcoming a period of further recuperation, we left the sledge, now almost buried, and ascended in blowing sleet to find a camping site. To the south, and overlooking the pass, a low summit with a flat outcrop of stones met with final approval, and we hurried back to the sledge and completed a somewhat exacting twelve hours' journey by porterage of the heavier loads.

The Rock Divide and the Eastern Glacier System.—Throughout the following day the bad weather continued, but at midday on August 15 a temporary clearing across the plateau allowed a determination of position, which was about 18 miles true north-east of Bruce City. The peak (3468 feet) upon which we had camped formed an unpretentious link in the rock divide, and its stony summit outcrop was identified by Odell

as part of the Hecla Hook Series, consisting here of quartzites and shales. In certain areas the rock blocks of the outcrop appeared to be grouped systematically along circular arcs, suggestive of a rute-mark formation, and excavations showed that the regular structure extended down into the solid rock.

Towards both the north and the south the hill was separated by passes from higher snow-covered summits rising to over 3500 feet, one of which we visited, and referred to as "Our Lady of the Snows." Both passes gave ready access from the ice plateau to a small névé basin on the eastern slope of the divide, draining through two narrow outlets into a large glacier. The mouth of the more northerly outlet was decorated by a curious landmark in the form of a family of some ten pointed pinnacles.

Our further programme was to follow this glacier, which became known to us as the Oxford glacier, for about 8 miles to a corner, beyond which the topography was at the moment obscure. Hopes were still entertained that fair conditions would allow us to extend a forced reconnaissance on ski well forward towards the east coast.

The weather on August 16 gave us some reason to infer that our united supplications had at last been heard. With shafts of sunlight riding here and there slowly across the dazzling landscape, we took our leave, and with all attainable grace endeavoured to control our ski—and the sledge! whilst the latter towed us at alarming rates downwards over the steep frozen slopes of the névé basin. Our technique of retardation was improvised, and did not scorn such simple artifices as bodily prostration or complete subversion. In due course we passed from the névé basin through the more southerly of the two outlet valleys, and were soon following the sledge in a more ordered fashion down the gentler inclines of a wide snow-covered glacier. Both to the north and south, extensive blue areas of water-logged snow added a welcome colour tone to the scene.

The occasional crevasses appeared to be well choked, and after testing several we proceeded confidently without checking speed. After luxurious progress for about 3 miles, a halt was made for photography, close to a small precipitous rock face, evidently of dark limestone, dipping north-east. The cliff, which we referred to as Fulmar Cliff, was much esteemed by the fulmar petrel (*Fulmar glacialis*) as a breeding station, and numerous fox tracks in the vicinity showed that this fact was already known to others than ourselves. In the Oxford glacier area fulmars flew over daily both eastwards and westwards; but Longstaff noted that those nesting on Fulmar Cliff came from the direction of Klaas Billen Bay. Several ivory gulls (*Pagophila eburnea*) also paid a passing visit here, probably coming from their known breeding stations about Olga Strait *en route* for Ice Fjord.

Our change of position had brought us abreast of two large tributary glaciers, descending, respectively, from the south and the north, and on

continuing we encountered a slight temporary rise of surface, originating probably from the cumulative effect of these tributaries. At the borders of the glacier the hills showed alternations of light and dark rock outcrops, which appeared to correspond across the glacier and represent limestone and carbonaceous or, possibly, bituminous shales respectively. A geological account of the district will be issued elsewhere by Odell.

In due course, keeping close to the northerly border, we passed a remarkable finger of dolomite, projecting into the glacier and terminating in a small precipitous knoll or "rognon" about 70 feet high, decorated with a perched block. Hummocky ice beyond forced us diagonally across the glacier towards the steep southern border range, a distance of about 2 miles. At this stage running conditions deteriorated, and we approached the opposite bank, racing mists from the south: the northern sky, too, was rapidly filling with a canopy of grey and silver fleece, and we looked for a sheltered camp. Towards evening a flat patch of scree below some crags found particular favour, since a clear pool close by, trapped by an ice curl, foreshadowed novelties in cuisine, not permitted under the more Spartan regimen of snow-melting. During the day we had advanced over 7 miles, and had dropped over 1100 feet in altitude; the point reached was situated 25 miles east-north-east from Bruce City.

After two and a half days of enforced idleness, during which we remained in the tent, sleeping or listening to the vagaries of a blizzard, the country emerged again, if somewhat coyly, from its humid draperies. At midday on August 19 an ascent was made to the crest above the camp, and a traverse of the border range effected south-westwards to the culminating point—a snow dome exceeding 3000 feet in altitude. The range is formed mainly of limestone and dolomites, dipping east and quite devoid of fossils; to the east, however, and across another glacier, a steep parallel range indicated changes in rock character, possibly to the Carboniferous or Triassic suspected to exist in the locality. On the flatter portions of the crest polygonal markings were well formed, but on the slopes they tapered out into long lines of alternate stones and mud. Later in the day we retraced our tracks, and extended the traverse north-eastwards to a lower but more conspicuous rock summit (2967 feet), formed of slopes of Carbonaceous shales. Its dark and sombre appearance led us to refer to this peak as Svarttoppen (Dark Top), a name which originated in Longstaff's fertile mind and practically exhausted his Norwegian vocabulary.

The range then lost character as a continuous line of cliffs, and gradually dropped away in tongues of scree to a narrow neck of stagnant ice, evidently left by the retreating glacier. Beyond, a massive nunatak, whose appearance from certain view-points suggested the name "Lion Nunatak," represented the true termination of the range, and marked the outlet of the Oxford glacier into a vast expanse of ice, flowing at this point north-eastwards. A junction had here been effected with the more

southerly confines of the Russian map of the Mount Newton area, and the ice artery is identical with the great glacier observed by Sir Martin Conway, and later by Backlund. From Svarttoppen a long range of hills could be discerned at the farther border of the ice stream, culminating towards the north in steep granite bastions of the Mount Newton group, which emerged at intervals from mist and revealed complicated gateways for the many tributary glaciers of the system. Our view-point should have commanded the whole of the country to the east coast; but the final topography was not to be disclosed. For miles the main stream could be seen spreading, featureless, gently downwards, until it merged into a tattered curtain of white mist hung against a background of many blues, where the colour scheme played upon fancy, and constantly tricked us into the belief that this or that gradation was the coast-line and the sea.

Snow fell intermittently as we descended and crossed to the Lion nunatak. On the way to the summit we stopped to peer down at the fulmars, as they fluttered with anxious cries from their nesting-places in a crumbling cliff, which dropped 300 feet vertically to a narrow lakelet in the ice-folds at the base of the nunatak: morasses connected with the lake and extended far out into the glacier. The summit of the nunatak (2578 feet) was to be our farthest point north-east. We built a cairn, and turned back—not without regrets—for our last night at the foot of the Oxford glacier.

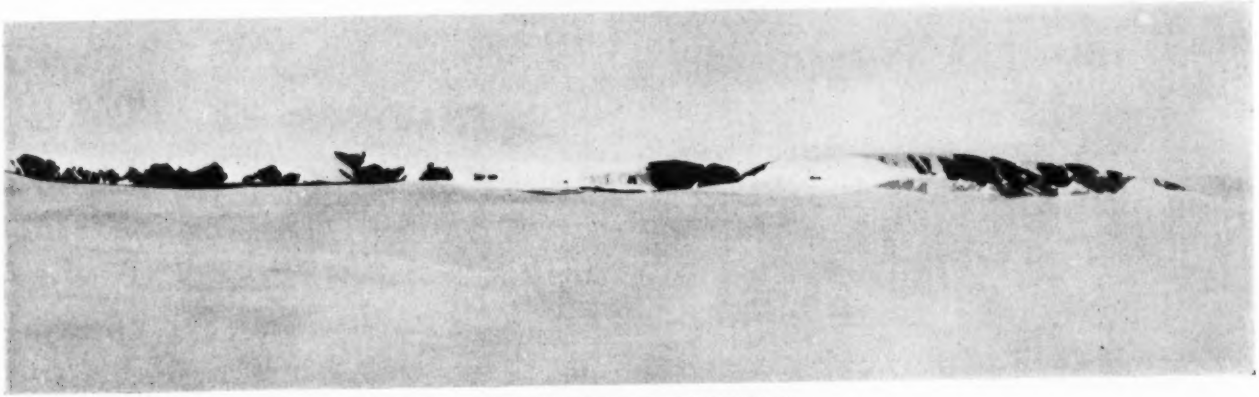
A small plant collection made by Longstaff in this area comprised nine flowering plants, many of which were gathered in bloom, and one grass. In his opinion these constitute a relatively new colony, due to improving conditions. The complete list, as identified by Mr. Wilmott of the British Museum, is as follows: *Papaver nudicaule*, var. *radicatum* (Rottb.); *Cochlearia officinalis*, var.; *Draba* (probably *D. arctica*)*; *Cerastium alpinum* (L.); *Alsine* (probably *A. rubella*)*; *Saxifraga cæspitosa* (L.); *S. oppositifolia* (L.); *S. rivularis* (L.); *S. cernua* (L.); *Poa cenisia* (All.).

The Return Journey.—Still hoping for exploration northwards from the site of our previous camp, we retreated on August 20 with a margin of five days in hand. A further delay of one day would have been legitimate but useless, since once again the country was enveloped in thick mist, and a cold north-easterly wind foreshadowed worse conditions.

In the return to the divide our main concern was to avoid ascent of either of the two wide tributary glaciers whose outlets had previously been passed. The course steered was close under the northern border range, but it proved unfortunate, since softly bridged crevasses and water-channels due to a minor tributary were extraordinarily plentiful. Constant reconnaissance was necessary when the direction of march happened to coincide with the line of the crevasses. After some delay, arising from the extrication of the sledge, which had partially broken through a bridge,

* Identification uncertain, owing to absence of flowers and fruit.

EAST FACE OF MOUNT TERRIER



LOOKING NORTH FROM CAMP IV.

THE OXFORD GLACIER FROM CAMP V.

LOOKING SOUTH-EAST FROM SVARTTOPPEN

we reached safer ground farther out on the glacier, and were rewarded by the sight of an arctic fox making its way at great speed towards Fulmar Cliff. The final ascent of the névé basin to the divide was extremely severe, owing to the wet condition of the snow, which tended to clog the sledge-runners; but a steady pull of two hours brought us, ten hours after departure, to the site of the previous camp.

On the following day a bitter wind developed from the north-east, which soon augmented to a blizzard, and confined us to our sleeping-bags, where we endeavoured unsuccessfully to keep warm. Cooking was impossible, but cold emulsions of glaxo and oxo with a previously prepared supply of melted snow proved very palatable. During the night of August 22 the gale increased, and the extreme exposure of the camp prompted some speculation as to the probable career of the tent and its contents, in the event of breakage of the guy-ropes. These tempestuous conditions lasted well into August 23, and left us two days to regain Bruce City. During this period the temperature on the *leeward* side of the tent never dropped below —5° C., but the bitter wind and frozen condition of the tent prohibited a move.

Our chance came in the very early hours of August 24, when Long staff, discovering that the wind had dropped, woke the rest of the party. A welcome thaw was rapidly bringing down the icicles from the tent, and we hastened to assist with ice-axes. Some hours later, by painful process, the camp was cleared, and we set out through fog across the undulating border slopes of the plateau. Even here, on relatively sheltered ground, the trail was all but obliterated, and before long Odell set a compass course for Mount Terrier. After 7 monotonous miles we found ourselves on a considerable down-grade, and, assuming that we had passed to the south of our outgoing route, we left the sledge and reconnoitred for about a mile in a west-south-westerly direction.

A sudden clearing showed that Odell had indeed successfully steered his course, but left us momentarily perplexed. The characteristic terraced face of Mount Terrier was close ahead and unmistakable, yet the background strangely unfamiliar. This illusion was delightful but transient; the recollection of recent blizzards flashed before our minds, and, piecemeal, the mysterious scene ordered itself into the Nordenskiöld glacier and its border ranges, masked in newly fallen snow.

We returned for the sledge, and six and a half hours after departure from camp reached our depôt and the spare sledge at the western edge of the plateau. For the descent we coupled up the sledges in tandem, and, still wearing ski, piloted both down the newly fallen snow almost to the foot of Mount Terrier. Beyond this point the glacier had changed appreciably, and the disappearance of many well-known snow bridges considerably exercised our ingenuity. Towards evening a refreshing rain fell, and revived us for that sequence of spasmodic struggles which ultimately brought our tandem over the ice hummocks to the foot of the Norden-

LOOKING SOUTH-EAST FROM SVARTTOPPEN

skiöld glacier. This concluded our twenty hours of labour, and we regained our base, during the early morning hours of August 25, on contract date.

On the return we received a cordial welcome from the field party of the Scottish Syndicate, who, under the charge of Mr. Mathieson, were now quartered at Bruce City. They ministered to our foremost want, and produced a copper full of boiling water. Longstaff in turn produced his *vade mecum*—which has since travelled with him to Mount Everest—and we bathed luxuriously.

With characteristic hospitality the Syndicate extended their original invitation and offered us a return passage to Norway. Captain Kristian Johanssen left at midday on August 26, and, after a skilful encounter of twelve hours with a severe cyclone, brought us without change of course to Tromsö on the 30th. Within a fortnight from the hour we had brushed our tent free from icicles in the interior of Spitsbergen, we found ourselves stifling in the London heat-wave.

You cannot survey what you cannot see! This aphorism, propounded by Sir Martin Conway in 1897, applies equally to the Spitsbergen of to-day. Our seventeen days inland had brought us fewer results than we had hoped for at the outset. Many days had proved utterly valueless; others had represented hours of unrelaxed watchfulness, without the pleasurable satisfaction attending forward progress. The few long marches we had accomplished told us that much could usefully and rapidly be done by a party more fortunate in their weather.

In a recent paper to this Society, the opinion has been expressed that "the thorough scientific exploration of an unfamiliar region—especially within the polar circles—entails continual work throughout at least three seasons." On this very reasonable basis, our sledge journey of 1921 would be classed as reconnaissance. The second stage—namely, the main spade-work of detailed investigation—still remains to be done.

In conclusion, we desire to express our indebtedness for invaluable assistance given by the Royal Geographical Society. From many other quarters much help and advice have been received, but full individual acknowledgment is here impossible. To Mr. John Mathieson and other representatives of the Scottish Spitsbergen Syndicate, to the British Vice-Consul at Tromsö, and to many others who in Norway so unfailingly assisted us, our special thanks are due.

Before the paper the PRESIDENT said: This is the last occasion upon which I shall have the honour of addressing you as your President.

I now have to introduce to you Mr. Frazer, of the National Physical Laboratory, who was with the Oxford University Expedition to Spitsbergen last year. He comes from the University of Cambridge, but somehow Oxford managed to get hold of him.

Mr. Frazer then read the paper printed above, and a discussion followed.

Mr. ODELL presented a summary of the geological results of the expedition, which will be printed in our next number.

Mr. WORDIE: It has been a great pleasure to-night to listen to Mr. Frazer's description of his sledging expedition into the interior of Spitsbergen. Looking at his wonderful photographs I was filled with considerable envy, because I once climbed some of the mountains behind Bruce City and formed the desire to penetrate some day into unknown Garwood Land. Now I have come here to-night and listened to Mr. Frazer's interesting account of that very country. I happened to be one of those who helped to found Bruce City three years ago. We put up two huts that summer. From Mr. Frazer's photographs, I see that the town has already doubled in size and that there are now four habitable buildings. It was very appropriate that the Oxford party should start from Bruce City, because their sledging expedition has carried on the work begun by Sir Martin Conway, by Professor Garwood and Dr. Bruce himself of exploring into the interior of Spitsbergen and proving that there is no true "inland ice." The British tradition in Spitsbergen dates of course from Stuart times when English seamen explored the bays and anchorages. At the end of the eighteenth century Phipps tried to sail along the north coast, Lord Nelson serving as one of his midshipmen. Exploration inland, however, only began a century later. It is very fitting that a new generation should now extend these interior explorations of Sir Martin Conway; and I think you will join with me in hoping that some day Mr. Frazer and Mr. Odell will be able once more to reach the head of the Oxford glacier, and this time to follow it right down to the shores of Hinlopen Strait.

Mr. JULIAN HUXLEY: There are one or two general points that have occurred to me. One is in connection with the curious markings, resembling typical polygon markings in some respects, seen high up on the rocks near one of the camps. These were in solid rock. Those who have not been in a country such as Spitsbergen can have no idea of the intensity of the phenomena of erosion. At all levels you get this extraordinary surface action, and these circular or polygonal marks, both high up and low down, as shown in the lecturer's slides. Those at low levels seem to be due to alternate thawing and freezing, which reduce the centre of the areas to mud and force the margins apart. But those on high ground appear to be different, because they are solid in the centre and crack at the edge. It seems to me that they are probably of different origin; attention should be focussed on them, especially by Alpine climbers, who should be asked to say whether they occur in high mountains, and thus help us to correlate the various types of the polygon marks.

In the second place, the existence of birds on the isolated Lion nunatak, nearly 3000 feet high and 30 or 40 miles from the sea, is of considerable interest. It shows us that we must be very guarded in our conjectures that the whole of Spitsbergen has been totally depopulated during the Glacial period. The existence to-day of twelve or thirteen species of plants and birds in such a barren and inhospitable situation indicates that a few organisms might have survived the Ice Age.

Finally, with regard to the disproof by the last expeditions in this region of the existence of any true inland ice in Spitsbergen, I would like to point out that in Spitsbergen you get perhaps one of the most interesting geographical series to be found in a short compass. For example, we pass from a true ice-cap in North-East Land; thence, in New Friesland, to a plateau such as was traversed by Mr. Frazer and Mr. Odell—almost an ice-cap, with highland ice;

then a much dissected plateau ; and finally on the west we find almost typical Alpine scenery. The great variation in so short a distance is due to the coexistence of a cold current coming from the north-east and a warm current coming from the south-west. And you get there an exceptionally good opportunity of studying, within the boundaries of one small country, what the state of the British Isles must have been at different periods during their emergence from glacial conditions.

The PRESIDENT: I am sure we ought to congratulate the Oxford University Expedition upon having brought back such very useful results. They have not only surveyed unknown country, but they have brought back geological and natural history results of very great value. I think perhaps that looking at the photographs one does not think of it as exactly a very attractive country, although we are assured by the travellers who go there that it has its attractions, even from the point of view of beauty. But I should imagine the real and deep interest lies in what was referred to by Mr. Julian Huxley : that you can study under existing conditions what was the state of these islands of Great Britain in the glacial period. We ought, therefore, to thank the members of the Oxford University for having gone there and for having enlisted, as they so often have to do, the services of their sister University. I am sure we shall give our most hearty thanks to Mr. Frazer.

THE REGIONAL SURVEY OF THE CROYDON DISTRICT

C. C. Fagg, F.G.S., President of the Croydon Natural History and Scientific Society

Read at the Afternoon Meeting of the Society, 13 *March* 1922.

THE Regional Survey of the Croydon district was undertaken by the Croydon Natural History Society as the result of a paper entitled "Some Suggestions towards a Natural History Survey of the Croydon District" read to the Society in 1912. The Society had indeed been carrying out and publishing what would properly be called regional survey work since its foundation in 1870, and the proposals were simply that we should formulate, and work to, a comprehensive plan. It was contended that such a plan "will give the Society a concrete scheme of work which will last for many years, providing activities for every section. It will of necessity revive the life of some of the sections which are now slumbering, and give greatly increased interest to the others. By correlating the work of all the sections, these will be brought into more vital contact with one another, and become dependent upon one another in a variety of ways. All this means that new life will be brought into the Society, and that many new members will be attracted to it. No other body is so well equipped as this Society for carrying out the work of such a Survey, and the results in a few years' time should be of great scientific and educational importance" (*Proc. Croy. Nat. Hist. and Sci. Soc.* 1912–3, pp. cxxxvii–cxl.).

The organization of the Society was, so far as it went, already well adapted for the purpose of the proposed survey. It had sections devoted to Geology, Meteorology, Botany, Zoology, Anthropology, Archæology, Microscopy, and Photography, but each was working along its own lines without reference to the others, or not working at all. It appeared also that the human side of the proposed survey was not adequately represented by anthropology, which was interpreted as the study of prehistoric man, and archæology, which was concerned but little with history, and less with social science. The writer therefore suggested that the Society, on the high authority of Sir E. Ray Lankester, should embrace Sociology as a branch of Natural History, and after some discussion a Sociological Section was formed. This section has lately developed a sub-section for Psychology, which, apart from its biological importance, is now seen to throw much light upon folk-lore, place-names, and other branches of regional research.

The organization of the Society thus completed, the next steps were to define the region and to work out the methods and technique of surveying, recording, and interpreting its varied phenomena. Much work on these lines had already been done by Prof. Geddes and his colleagues at Edinburgh, Prof. Herbertson at Oxford, Dr. Hugh Robert Mill,* Robert Smith and the group of British ecologists, and others, but much remained to be done.

I shall be better able to explain the part taken by Croydon in the development of survey methods if I first say something of the Regional Survey Section of the South-Eastern Union of Scientific Societies, which is an offspring of the Croydon Survey.

The S.E. Union is made up of some eighty local societies in the south-eastern counties from Essex to Hants, and is similar to the Yorkshire Naturalists' Union. It is a kind of miniature British Association, holding four-day congresses at different centres in the spring of each year.

We soon found that the Croydon Survey was bringing new life to the Croydon Society, and it occurred to me that other societies similarly situated might profit by the knowledge of our experience; for most local societies were languishing owing to various causes, which have been noted elsewhere.† Accordingly I introduced the subject to the delegates to the S.E. Union at the Congress held at Brighton in 1915, in a paper entitled "Regional Surveys and Local Societies,"† which resulted in the formation of a Regional Survey Section of the Union. The avowed object of the section is to encourage Regional Surveys in societies affiliated to the Union, and it has already accomplished much in that

* "Proposed Geographical Description of the British Isles, based on the Ordnance Survey" (*Geogr. Jour.*, April 1896, p. 345).

† The *S.E. Naturalist*, 1915, p. 22. See also F. W. Rudler, *S.E. Naturalist*, 1904, pp. 3 *et seq.*

direction by helping local societies to commence surveys, and still more by acting as a clearing house for ideas. The wider outlook and membership of the Union clearly gave it advantages over a single society in working out the best methods and technique of regional research, and the wider distribution of its Journal, the *S.E. Naturalist*, has given a more useful publicity to the committee's deliberations than could the transactions of a local society.

Thus while the actual field-work is done by the rapidly increasing number of societies that are undertaking regional surveys, the advances in technique which they make are gathered together by the S.E. Union committee, sorted out, and as far as possible published from time to time in the *S.E. Naturalist*.

We may now return to the two initial problems of the local survey society, viz. the choice of a region, or, more strictly, an area, and the formulation of a general scheme of work. The report of the S.E. Union Section for 1918 included a useful discussion of the advantages of the various types of area (*e.g.* circles, rectangles, river basins, administrative areas), but the committee were unable to lay down any hard and fast rules beyond the deprecation of circular areas, and the strong recommendation that the civil parish should form the smallest unit of area for survey purposes. A local survey area should consist therefore, as a rule, of a group of parishes clustered around a civic centre. In this the committee is at variance with Dr. Mill, who briefly discussed the same problem, and decided in favour of a separate Geographical Memoir for each of the 1-inch sheets of the Ordnance Survey maps. Dr. Mill's basis of division of the county by Ordnance Survey sheets was criticized by several speakers in the discussion that followed his paper, and on the whole it is perhaps well that the specific proposal of Dr. Mill was not more readily taken up, but that the seed sown by him and others has now germinated in the form of surveys of towns or cities and their surroundings.

The choice of an area at Croydon was difficult, and after much deliberation we chose a rectangle of about 200 square miles, which, although not a region in the strict sense, is a typical section of the well-marked belt of country surrounding the Weald, and comprises the geological formations from London Clay to Weald Clay. As to the question of method, the yearly reports of the S.E. Union Committee have contained useful contributions towards its solution, and sufficient experience had been gained by 1920 to enable them to publish an "Outline Scheme for Local Surveys" (*S.E. Naturalist*, 1920, pp. xxx.–xl.), dealing briefly with the subject under the following seven headings: (1) Choice of a local survey area and acquisition of maps; (2) Geological position and environment of chosen area; (3) Preparation of maps on 1-inch scale; (4) The conspectus of the survey; (5) Preliminary survey of area on 6-inch scale; (6) The Advanced Parish Survey; (7) Special surveys of the area.

In practice the several lines of work will be in progress simultaneously, though some of them are more advanced than others.

The main basis of all regional survey work should be maps. All the existing maps of the region are the surveyor's chief tools, and the results of his labours in the field will find their chief expression in new maps.

One of our most valued members at Croydon is Mr. W. Whitaker, who, in his recent Presidential Address to the Geologists' Association,* said: "No one is thoroughly equipped for local scientific work without having the 6-inch Ordnance Map of the immediate neighbourhood. It would be a good thing if our many local societies kept a set of such maps of their districts whereon the observations of their members could be brought together, for the use of the society generally and for the preservation of valuable records. A good map is a wonderful tool, and one which all observers should learn to use."

It would be difficult to over-emphasize the importance of getting as much as possible of the description of the region into the form of maps. Even geographers do not always realize the very wide range of their useful application and the importance of developing cartographic symbology.

For field-work the current edition of the 6-inch Ordnance Survey Maps are essential, and for reference the first and second editions are invaluable; particularly the first beautifully engraved edition, which contains much topographical detail that is omitted from later editions.

The area we have chosen at Croydon is covered by some forty 6-inch quarter-sheets, and up to the present we have used four sets of them apart from the numerous copies, amounting to several sets, which individual workers have acquired. We want many more sets of the 6-inch maps, but one set now costs £3, and our funds do not permit of the purchase of them at the present time. Further, our work at Croydon is seriously handicapped for want of one set of 25-inch maps of the region, which would cost us about £30.

Several of those present at the reading of Dr. Mills' paper expressed the opinion that Government grants might be obtained for work of the kind proposed, if done by voluntary workers actually living in the localities described. May I venture to suggest that even now such grants might take the form of issuing Ordnance Survey Maps to accredited societies engaged in regional survey work at a nominal price, or even free? The principle is already recognized, not only by the issue of cheap maps in quantities to schools, but by the presentation of sets of 6-inch maps of whole counties to societies approved by the Department for carrying out archæological surveys for the purpose of revising the data on new editions of the maps. When it is recognized, as sooner or later it must be, that regional survey societies are doing work of very great value to the Ministries of Health, Education, Agriculture, Transport and Labour, and the Board of Trade with its Development Commissioners

* Not yet published.

and Department of Industrial Research, it will be seen that for the Government to supply the raw material in the form of maps is a very good investment.

Although the 6-inch maps are essential for field-work, maps on the 1-inch scale are more suitable for summarizing the results in each subject. When we had decided upon our area at Croydon, we were faced by the difficulty of requiring abundant maps. We started laboriously to copy by a duplicating process the 1-inch and 6-inch Ordnance Survey maps with the sanction of H.M. Stationery Office, but the results, while suitable for rough use in the field, were not good enough for permanent records. We then discovered that we could get 1-inch maps of our area specially printed by the O.S. Department at a very cheap rate by taking two hundred or five hundred copies, and we at once obtained the larger number, printed in grey ink so that our manuscript additions would stand out upon them. Realizing the great importance of geology as affecting the physical features, vegetation, animal life, and human activities and institutions of the region, we were at some pains to produce a good geological (Drift) map, based upon the new 6-inch Geological Survey maps so far as these were available, and otherwise on the old 1-inch Geological Survey maps modified from the field notes of several trustworthy geologists. Having produced this geological map, we had it over-printed in outline in brown ink upon 100 of our grey 1-inch maps for use when mapping such features as natural drainage, vegetation, agricultural or mineral industries, and others to which the geology gives special significance. In the original maps colours are used as well as symbols to aid visualization of the subject mapped. The following is a list of the maps we have made, are making, and intend to make. The third category is, of course, capable of indefinite extension, and new ideas continually present themselves as the work progresses. In some subjects, *e.g.* geology, vegetation, earthworks, field-names, and surface utilization, it is desirable to make fair copies of the 6-inch maps for placing with the collection for public reference as well as, or instead of, the summarized version on the 1-inch scale.

List of Maps prepared **, in course of preparation *, or desired.

*Map on $\frac{1}{4}$-inch scale of S.E. Counties, showing the position of Croydon with reference to lines of communication, etc., from London; its position regarding the counties of London, Surrey, and Kent, and Greater London, etc.

Maps of Survey Area on 1-inch scale.

**Index to 1-inch, 6-inch, and 25-inch Ordnance Survey Maps contained in the area.

*Index to areas covered by various local guide-books, parish histories, etc. (Probably several maps required. Supplemented by bibliography of the Region.)

Geology.

**Drift Map. (Also made as transparency for placing over other maps.)
Eighteen 6-inch Drift Maps copied from MS. Maps at Jermyn Street.
*Distribution of "Drift" constituents.
Solid Geology.
*Numbered Index to all geological exposures whether large or small, and whether now visible or recorded in the past. This map is the index to a set of descriptions of the sections, each on a form printed for the purpose.
*Soil Map. (Field-work proceeding.)
*Map of zones of Chalk Formation. (Field-work proceeding.)

Meteorology.

Wind.
Sunshine (Isohels).
Pressure (Isobars).
Temperature (Isotherms).
**Rainfall (Isohyets). Average annual. Thirty years.
** Do. 1898. Very dry year.
** Do. 1903. Very wet year.
(These three maps prepared for the Society by Dr. H. R. Mill. Other rainfall maps by J. E. Clark, F.R.MET.S.)
** Do. each year 1914–1920.
* Do. 1921. (To be continued yearly.)
*Average rainfall (thirty years) for each month of the year.
**Course of violent hailstorm of 18 July 1918.

Orography.

**Contour Map, 100-feet intervals. (Several copies with different methods of colouring.)
Contour Map, 20-feet intervals.

Hydrography.

**Rivers and streams, river basins, minor water-partings.
**Sites of Bourne Flows. (Prepared by the late Baldwin Latham, M.I.C.E.)
*Distribution of damp and wet soils.

Vegetation.

*Ecological Map. (Survey being made on 6-inch scale for reduction to 1-inch scale.)
*Types of woodland only.
(Maps showing distributions of various important, interesting, or uncommon wild flowers or species of animals, and large-scale maps of selected small areas of natural vegetation, will also be prepared.)

Prehistoric Man.

*Palæolithic sites showing various cultures.
*Neolithic sites, hut-circles, barrows, etc.

*Bronze Age. Sites of bronze hoards, British earthworks, etc.
Early Iron Age.

Roman Occupation.

**Sites of villas, Roman roads, temples, coins, pottery, etc.
Attempt to reconstruct map during Roman occupation.

Saxon.

**Map illustrating early Saxon settlement of Survey Area.
*Map showing position of all known burial grounds, etc.
*Large-scale plans of villages to illustrate types of village communities.
Map showing sites of mediæval manor houses and manors, supplemented by large-scale maps showing, as far as possible, the actual lay-out of each manor.
Map showing the old open common fields, supplemented by large-scale maps illustrating the awards under the Enclosures Acts.
**Ancient Hundreds.
*Place-names. Field names on 6-inch maps.

The number of historical subjects that lend themselves to cartographic representation is practically unlimited. The Croydon Survey, however, is concentrating first on the preparation of maps depicting the present economic and social conditions. Most of the maps below will be followed in due course by maps dealing with the same subjects at different periods of history.

Economic and Social.

**Population on Parish basis, 1911.
*Population on Parish basis, 1921.
Population, actual distribution 1911 and 1921.
Distribution of Ethnographic Types.
*Agriculture and Forestry.
**Mining and quarrying industries.
Manufacturing industries.
*Communications. (Roads, canals, and railways.)
*Footpaths.
**Accessibility to railways.
Markets and market-places.
**Local Administrative areas. (Civil parishes, urban and rural districts, etc.)
*Schools and colleges.
**Commons and public open spaces, nature reserves, etc.
*Sports and recreations.
**Churches and Ecclesiastical Administrative areas. (Ecclesiastical parishes, deaneries, dioceses.)
**Area within which coal and wine dues were formerly payable.
**Statutory areas granted to gas companies. (Prepared by Croydon Gas Coy.)
Areas served by various water authorities.

Areas served by electricity.
Various maps showing vital statistics.

A perusal of the above list of maps will reveal many points of interest. Firstly, it will be seen that some of the maps can be easily prepared without even going into the field. The 100-feet contour map, and that of the civil parishes, are made by simply accentuating the data already on the faintly printed maps, and applying suitable colour washes. Others, such as parish populations and ecclesiastical boundaries, require reference only to published or otherwise available records. But the majority of the maps can only be prepared after a survey of the region itself has been made, and in many cases (*e.g.* vegetation, earthworks, geological subjects) this can only be done by advanced workers in their respective fields. The field observations required for the preparation of a large number of the maps can be carried out by any one of ordinary intelligence. To save going over the ground separately for each of these, it is a good plan at the outset to make a preliminary surface utilization survey, and mark the results on a set of 6-inch Ordnance Survey maps. I have already dealt with the methods and uses of such a survey (*S.E. Naturalist*, 1920, pp. 31–40), and it will suffice now to say that during the past two years a few members of the Croydon society have between them examined every unit of area shown on the 6-inch Ordnance maps of the 200 square miles under survey, and coloured a set of maps to differentiate some thirty categories of surface utilization. We thus have first-hand data for the preparation of many of the maps mentioned in the above list, as well as a permanent record of the state of the district at the time of the survey, and when the acreages under the various categories have been abstracted and tabulated for each parish many interesting comparisons and contrasts will be presented.

A second point which may be mentioned in regard to the list of maps is that the different sections are very unevenly represented by completed maps. This defect will be removed in the course of time. The work is still in its initial stages, and portions of it are done as suitable workers undertake to do them. One advantage of having a general scheme of work is that its parts, whenever they are executed, will finally fit together to make a complete whole.

Each map or series of maps is or will be sufficiently described either in the space provided for "subject" on the margin of the map itself, or in a separate memoir. The aim being always to make written descriptions as concise as possible, free use is made of tables and graphs. Each subject is also illustrated by a selected series of photographs specially taken by members of the Photographic Section. The whole of the growing collection of maps, memoirs, and illustrations is kept for public reference at the Central Library.

There are many points that might be mentioned in connection with each map, but I must confine my comments to a few.

The index map to geological exposures is made possible by the surface-utilization survey. Every exposure is now marked in red on the set of 6-inch maps, with the added note "sand," "chalk," "clay," "gravel," or as the case may be. It is for the geologists to examine each exposure.

The compilation of field-names on a set of 6-inch maps from tithe-maps, manorial records, old deeds, and old inhabitants is a work of great importance. These names often throw light upon obscure historical subjects. For instance, Mr. E. Hart, of Bletchingley, finds the name of "The Streunes" attached to a field on the summit of White Hill in that parish. This name he traces to the Saxon "streone," a watch-tower, and the suggestion of a watch-tower on White Hill in Saxon times is very helpful in considering the "Saxon Settlement of N.E. Surrey."*

The distribution of surnames as found on gravestones, in registers, or even in directories is full of significance. The prevalence of the names Fuller, Tucker, or Walker, for instance, denotes the presence in past times of the cloth-weaving industry. Near Croydon there is an estate called "The Ballards" (bald head), named probably from the headlands of Blackheath Beds which are bare of trees. Ballard is also a local surname, and its bearers have all been noteworthy for the same feature (W. H. Mills, "Vanishing Rural Handicrafts," *Trans. C.N.H.S.S.*, 1914–15, p. 21).

The making of many maps has brought out very prominently the marked contrast between the eastern and western half of the survey area as divided by the Brighton Road. This contrast is well seen in the two sections now shown, which represent not only the geological formations but several of the other features of the region that are imposed upon them. The presentation of these sections in an unfinished form anticipates in some measure a paper that is being prepared on the subject. They are almost self-explanatory, representing sections across the whole atlas rather than across the geological map alone. They are not actual but "averaged" sections arrived at by a method that will be described in the above-mentioned paper. Such "averaged" sections can only be usefully made for districts which do not vary essentially throughout in the direction at right angles to them. An averaged section taking in both the eastern and western half of our area, for instance, instead of giving a good typical section, would be unlike anything that exists, and without value.

It will be observed that while the succession of geological strata from north to south is the same in both sections, the contour and other features are often in contrast. The average altitude is about 100 feet less on the western side. This may be due partly, as Mr. G. M. Davies thinks, to the presence of a geological fault coincident with the Brighton Road. If he can prove that fault, it will be of great interest as the ultimate cause of all the differences between east and west. A few of these may

* The subject of the address of our past President, Albany F. Major, O.B.E., *Trans. C.N.H.S.S.*, 1920–21, pp. 53–79.

be mentioned. On the east there is a considerable Tertiary escarpment. On the west the Tertiary area is flat and largely covered by river gravel. Its surface is usually at a lower level than that of the chalk outcrop. Springs issue from the chalk at frequent intervals, and the streams to which they give rise flow northward on to the Tertiaries. Hence on the west the early village communities were closely packed along the line of the chalk outcrop from Croydon to Epsom, while on the east, where there are no corresponding springs, the villages and townships are scattered. Again, the dry valleys of the chalk area run typically from south to north in the east, and from west to east in the west, a contrast of great significance in relation to the later phases of the denudation of the Weald. The place of the Clay-with-flints, with its coppice and wheat in the east, is partly taken at the surface in the west by extensive gravelly deposits of probable Pliocene age, giving rise to wide expanses of heathland and fashionable golf courses. The Lower Greensand forms a high ridge in the east which is almost absent in the west. These are a few of many points of contrast, all of which have interesting historical and social corollaries.

I have been able within the compass of this paper to give only a very inadequate account of the scope of the work we are endeavouring to carry out, still less of its value for education, town planning, and rural development. Perhaps I have said enough to show that Regional Survey work comes well within the traditions of the Royal Geographical Society; that it is, in fact, nothing but intensive research in geography, if that term is understood in its widest sense.

Before the paper the PRESIDENT said: There is an old saying that it is always darkest under the lamp. I think that must have been invented before the time of electric light. Anyhow, it is a very true proverb, and I do not think we in this Society have had a lecture upon geography so near home as that to which we are going to listen this evening. Perhaps the time will come when we shall hear something of the geography of Kensington Gardens. This evening, however, Mr. Fagg has very kindly come to tell us something about the geography and the natural history of Croydon. He is the President of the Croydon Natural History and Scientific Society, and I have much pleasure in introducing him to you and asking him to give his address.

Mr. Fagg then read the paper printed above, and a discussion followed.

Dr. J. W. EVANS: I have always had a very great interest in the Croydon Natural History Society, although I am not a resident in Croydon, and I believe that it is doing splendid work. You have heard from Mr. Fagg something of that work, and you have understood, to a certain extent, all the various directions in which the members of the Croydon Natural History Society are working to elucidate the special features of their district. But much as is being done, to my mind there is still more to be done. There are still more directions in which I hope the members of this Society will strike out. There are many details to which Mr. Fagg has not referred, for instance the ethnological study of the district; the investigation of the sources of the population; the different portions of England from which the present population of Croydon

has migrated. There are a number of archæological questions, especially one that is very dear to me, that is to say, the record of the field-names and of the local place-names which have been far too much neglected. There are all sorts of directions which anybody might suggest according to his own particular interest. In hearing everything that is being done in Croydon I cannot help asking myself what is being done in other places. In many localities absolutely nothing is being done to excite the intelligent interest of the inhabitants in the district in which they live. I only wish Mr. Fagg could manage to infect some of the other outlying suburbs of London with the same zeal which is found in Croydon. At this late hour I will not occupy your time longer. I am sure we all wish well to the Croydon Natural History Society and the general movement of regional studies such as have been described this evening.

Mr. C. E. N. BROMEHEAD: I have many times had occasion to make use of the *Proceedings* of the Croydon Natural History Society, and found them invaluable in keeping records of various finds, mainly geological; but it is most refreshing to find what a variety of subjects they are undertaking. I tried to indicate a week ago the connection between the geology and the history of London. Mr. Fagg and his Society are trying, one might say, to connect everything. It is an old saying that one cannot know anything perfectly unless one knows everything, and I am sure this co-ordination work will be most valuable. There is one little point arising out of what Mr. Fagg said that particularly struck me. He mentioned the hard bands in the Chalk. I am thinking particularly of the Melbourne rock at the base of the Middle Chalk; below that the layer of the Chalk is much more clayey than above it. In West Kent—and I am thinking rather of the district to the east of the Croydon region—the Pilgrims' Way, which, as we most of us know, is certainly pre-Roman in origin, almost invariably runs exactly on the outcrop of that hard bed. The reason is twofold: one that is hard and therefore a good foundation for a road; the other that the chalk below it, having more clay in it, is more suitable for agriculture, and the road runs at the upper limit of the cultivation at the base of the Chalk scarp. I should very much like to know whether the same connection between geography, geology, and archæology is to be found in the Croydon area.

Mr. FAGG: The Pilgrims' Way, so far as it is agreed in our area, is mostly either at the top or bottom of the hills. It goes up and down and not, I think, definitely along the outcrop of the Melbourne Rock. But do you not think the fact of that outcrop being hard has made a natural ridge, and added a third reason for the Pilgrims' Way following it when it does so?

Mr. BROMEHEAD: I think so, certainly.

The PRESIDENT: I think Mr. Fagg has made us all realize the magnitude of the task which these Societies have undertaken, but we also realize the value of it, and we hope that they will continue their work and carry it out to a successful completion. Of course you realize that it must require an immense amount of co-ordination and the help of every kind of specialist at their command. You will now wish me to thank Mr. Fagg very much indeed for his interesting paper.

SOME NOTES ON THE LAKE CHAD REGION IN BRITISH TERRITORY

F. W. H. Migeod

IN the middle of Africa, on the southern edge of the Sahara desert, is a vast plain. On this plain two rivers discharge their waters. They are the Shari from the south and the Yobe from the west. These discharged waters are Lake Chad.

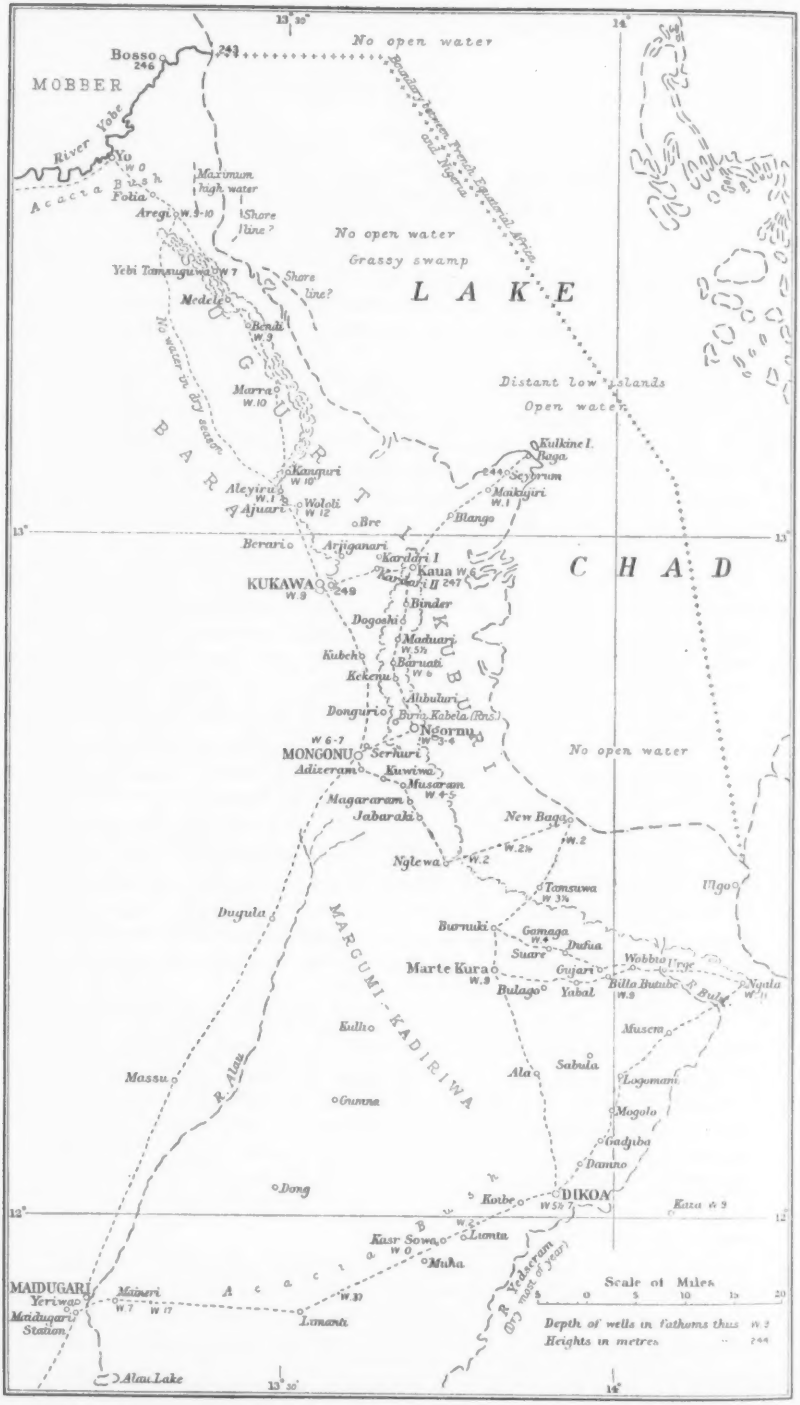
Formerly other rivers also discharged in the same area; but they are now dried up. Yet others, being smaller, have not force enough derived from their gradients to reach the lake. Their waters are scattered while yet at a distance. Still, were the lake to extend in size to no great degree, the waters of these rivers would indeed meet the lake water. The rivers that do not meet the lake are the Alau, the Yedseram, and the Albeit.

Whenever there is a good rainfall in the highlands to the south the level of the water in this vast swamp rises and spreads out on the plain in proportion to the additional quantity of water poured in. It retreats when the evaporation and absorption by the soil have overtaken the influx of water. If there is also a good rainfall in the western highlands in the same year, an exceptionally high lake is the result. This is now rare, as the river Yobe has for the last thirty years been carrying less and less water, and one big arm, the Komadugu Gana, has not carried water for, some say thirty-five years, others not since Rabeh's time, that is between 1894 and 1900. The general desiccation that is going on, and which I mention below, affects Lake Chad, therefore, in two ways: there is less rain direct into the lake, and less water by the river Yobe.

From the south side by the river Shari there is no reason to presume any reduction in the quantity of water brought down. Only the inevitable yearly fluctuations, due to variation in the rainfall in the far south, need be taken into consideration.

In Denham's drawing of Lake Chad in about 1824, the line of the water on the south-west and west comes very near the bounding line of dunes. In Tilho's map of 1906 the edge of the lake varies from about 3 to 5 miles farther out. Again, from what I observed myself and from native reports supplied to me, the shore-line as it was in April 1922 seemed to have receded on an average of yet another 3 miles. In some places it appeared to be even more, as at New Baga in the south-west corner. Actually this means very little, for it is often difficult to decide what is the water's edge.

Besides fluctuations due to the varying rainfall in far distant regions, there is further to be taken into consideration the annual variation like a tide due to evaporation and absorption. At New Baga I found it had been about a mile since last full water. The lake had reached Seyorum



Sketch-map of the south-western shore of Lake Chad to illustrate the paper by Mr. Migeod.

village in 1921, but I had to go 1¾ miles from there to the market huts. The water was still receding, and there was about 300 yards more of mud before the boats could be reached.

It can only be by continuous observation and by a record being kept with precision that any definite facts can be arrived at. The French have, I believe, an observation station on their side of the lake, but in British territory nothing has been or is being done.

The following are a few notes relating to the advance or retreat of the shore-line. In 1823, according to Denham, the water was close to Kaua and Bre. In 1851 a boat was launched by Barth's expedition near to Bre, and in 1855 Ngornu was reached by the water. When Seyorum was visited, it was on an island.

In 1871 the water came to Kukawa. Then in a year which was probably 1902, from the information supplied to me, the water reached Mongonu, having passed Ngornu. It also reached Kaua. At both Mongonu and Kaua the date supplied to me worked out at 1902, since they said twenty years ago; but I understood Ngornu to set it at thirty. Still there may have been another flood at Ngornu in 1892, for owing to Ngornu's nearer position to the lake, the close approach of the water might attract less attention than in towns farther back, and it does not follow that the flood did not reach the other towns in that year also. My informants might merely have omitted to mention it. In August 1921 the water again came quite close to Ngornu, but did not pass it. Kaua claims that two previous towns of that name were eaten up by the lake, the present town on a dune being the third built. Still this does not necessarily imply that the sites were not vacated again by the water.

Off Seyorum is an island of no great extent called Kulkine. It was, I was informed, formerly inhabited by the So, the ancient inhabitants of the country; but it is now unoccupied. At the time of my visit it was half a mile from the landing-place, but I was told it was joined to the mainland in the year 1914, which was a year of famine in the country owing to the failure of the rain. In crossing to it the depth of water I found to be about 2 feet and the bottom sand resting upon mud.

In the above record, therefore, there is no evidence of a general retreat of the water from the time of Denham's visit in 1823 until 1902. Since then it must be admitted to some extent, and this drying up coincides with the complete cessation of one arm of the river Yobe, and with the smaller carrying capacity of that river generally, a point I deal with in detail below. The reduction of the Yobe water, however, affects the southern portion of the lake much less than the northern portion, where, I understand, one lobe of the lake in French territory is now completely dry.

The theory has been put forward that there is an underground exit by which the water of Lake Chad escapes, though it is not quite clear

where it could escape to. The only depression that is possibly a trifle lower than Lake Chad lies to the north-east near Borku. The gradient, however, if it exists is very small, and with the great distance the difference of level becomes insignificant. Nevertheless, that much water is absorbed in the ground is supported by the fact of water being near the surface at a distance from the lake; for the shallow wells in all the towns surrounding Lake Chad, anyhow on the west and south-west side, at a distance of from 10 to 20 miles, no doubt receive their water from that source supplemented by local rainfall.

Under Bornu there is a big reservoir of subterranean water. To be precise, there are two layers of water. The upper one extends some distance from Lake Chad. The deeper one possibly derives its supply from the distant mountains. These I will now describe.

The bed of Lake Chad on the west side consists of about a fathom of white sand resting on mud, which no doubt extends to a considerable depth, and is itself an impervious clay bed. Outside the lake, however, the sand is wind-blown and deposited irregularly on this same mud or clay, which varies in colour from nearly black to grey. There are great expanses of this dark-coloured clay, extending many miles in places, round the southern and south-western sides of the lake; and it is bare of sand. It goes by the name of "firki." Although by origin it is a lake deposit, the lake water has ceased to cover it in the wet season owing to the shrinkage of the lake itself, but it has been continued in the same state through being submerged in rain-water during a number of weeks every year. The rain-water lies there till evaporated or absorbed, for there is practically no slope down to the lake. Under this clay deposit, which is generally about 3 feet in thickness, is a deposit of sand often if not always of a reddish colour. This may be only a few feet deep, and then comes a clay of a colour from pale grey to white and of great and unknown depth. With regard to the blackish clay, it is possible that it is of much greater thickness within the lake where the deposit is still presumably in process of formation, than it is outside where possibly it thins away in proportion as it is distant from the lake.

The surface or lake water descends and rests upon the white clay bed, and the shallow wells are dug so far. At a greater distance from the lake than its water reaches by percolation, the white clay has to be cut through to a great depth. The water may be at as much as 30 fathoms, and even a greater depth is not uncommon. The shallower water has the appearance of lying in an almost unbroken bed, but the deeper water by no means invariably does so. It is true there seem to be subterranean expanses in places, but elsewhere water may be found in one place and a few yards off there will be none at even a greater depth. In these cases it is no doubt a subterranean river or creek that has been tapped, and the second sinking has struck the bank.

In order to give some idea of how the water lies, I will give the depths

of the wells I met with along the route I followed. The months were March and April while I was in the vicinity of the lake, but the period of the year would only affect the surface wells, for I was invariably assured that the deep wells were unaffected by the season.

At Maidugari water is got from the bed of the Alau river in which there are pools, or if purer water be required a small hole will be scraped in the sand and water obtained a foot below. This is river water. Going on now the three days' journey to Dikoa, a distance of about 54 miles, on the first day water was at 7, then at 17 fathoms. The first might be Alau water filtered through, but the second is doubtful. The day after the water dropped to 37 fathoms, but a few miles beyond surface water was available at a depth of 3 or 4 feet only. At Dikoa the water is at 5½ fathoms, and is brackish. Then 4 miles on is the Yedseram river with water in the dry season at 4 feet below the surface of the sandy bed.

In this line of about 60 miles there are, therefore, four independent sources of surface water and one deep source, the 17-fathom supply being doubtful, though probably to be reckoned as a deep source. If the ground were all sand down to the greatest depth to which a well had been sunk the surface water would rapidly descend to that level. On the contrary, it is held up by an impermeable stratum. It would therefore seem of necessity that the deeper water is of quite a different origin.

All round the border of Chad from near Ngala to the Yobe river is a ridge. In the south it is low and has breaks in it in the form of shallow runnels, all dry when I crossed them. In that region the ridge is difficult to follow; but all up the west side it is without important break, and rises to as much as 50 feet north of Kukawa. It broadens and contracts and has branches. This ridge is to outward appearance sand, but if it is examined it will be seen that its core or base is the black clay raised by a vertical lift, or perhaps it may be by lateral pressure. This rise has caught the wind-driven sand and held it. I tested it in a number of places.

Along this ridge, which the lake cannot penetrate, the flooding behind being due to local rain-water, are the principal towns of the lake region of Bornu. The wells are usually sunk in the clay at the lower edge of the sand dune, and average from about 9 fathoms on the south to about 6 fathoms on the west. Some of the wells are brackish and some quite fresh; and the clearer the water the more brackish it is. In the same town there are fresh and brackish wells in close proximity to each other. The water of the lake itself is quite sweet. Among the towns where there is this important difference in the quality of the water are Dikoa, Ngala, and Marte. At Aregi the whole of the water supply is exceedingly brackish.

I followed three different lines from the ridge running perpendicular to the lake, and this is how the water varied. Going from Marte Kura to New Baga the water at Marte was at 9 fathoms; at Tamsuwa it was at

3¼ fathoms and brackish; at about 3 miles from New Baga it was 2 fathoms; and at New Baga itself, a bare mile from the lake the water was 3 feet down in the sand. On a second line from New Baga to Nglewa, there was water halfway at about 2½ fathoms, and a short distance from Nglewa at 2 fathoms. On a third line towards the lake: at Mongonu water is at 6 to 7 fathoms, according to the sinking place on the dune. Then between that town and Ngornu is a well of 5 fathoms, and at Ngornu they are from 3 to 4 fathoms, the latter wells varying according as the lake approaches the town or recedes. On a fourth line towards the lake: at Kukawa water is at 9 fathoms and generally sweet; at Kaua 6 fathoms; Maikujiri 1 fathom; and at Seyorum water is got from standing pools in connection with the lake.

At Aleyiru about 10 miles north of Kukawa I was interested to find two water supplies, a surface one and a deep one. Aleyiru is on the dunes, but on the clay below sweet water can be got at one fathom only. Behind the rest-house, which is a mile to the north of the town, is another supply at the little village of Kanguri. This village is on the east side of the dune, Aleyiru being on the west. Here the water is at 11 fathoms. Again, at a place named Wololi, between Kukawa and Aleyiru, water was at 12 fathoms, and this was on the flat and on the west of the dune.

This would seem to show that the surface water on the large inland flats, which the lake water never reaches, does not succeed in descending very deep, and the lower water comes from a different source. The distance from the lake would be about 20 miles. It is therefore for experts in subterranean flows to decide whether it is the lake water that is descending at the rate of 3½ vertical feet in the horizontal mile.

As to the age of this ridge, which makes so effective a barrier to the spread of the lake water into the interior of the country, its origin is possibly to be put down to the pressure or weight of the mass of lake water exercised at some distance inside the lake, and still in operation. That the ridge is ancient is clear from the fact that argillaceous ironstone exists in it. I found this ironstone between Mongonu and Ngornu and also at Kukawa, and it is worked on a large scale, supplying all the local region with iron, I am informed.

The blackish or dark grey clay, which is the surface stratum over so many hundreds of square miles, is spread on both sides of the ridge, and also under it. Possibly it was deposited in far ancient times by the lake when its limit was the ridge of sand on which Maidugari now stands. This secondary ridge, which is cut by the Alau river at Maidugari, has small gravel on it at a high level, and some of the lower sand in it is reddish. This ridge comes from the east to where Maidugari is, then turns north-west, and I am informed continues in a northerly direction. Though of great importance in a flat country like Bornu, its height is actually so slight that it is not marked in maps which indicate altitudes. Nevertheless it represents the ancient boundary of a far larger Lake Chad

than the present lake; and I believe I am right in saying that all the blackish clay I have referred to lies within its circumference.

Nevertheless this clay, although undoubtedly produced originally as a lake deposit, has continued in its early state through annual rainfall floodings, the water lying on it for at least three months. Possibly for a vast period of time there has been no tendency for the ground either to rise or fall. This applies all the more to the areas within the range of such streams as the Alau and Yedseram, which do not reach the lake but spread their waters out on the plain while still short of it. Similar mud flats extend a long way up the river Yobe. They are seen as far as Damasak, some 70 miles from the mouth of that river by road. Higher than Damasak the dark colour of the clay is not maintained, and it becomes more and more bleached.

These two lake boundaries no doubt both date from recent times, geologically speaking. If now the subterranean strata be examined, yet a third lake limit is indicated, of much larger extent, and which must have had a vastly longer existence than the two succeeding lakes which have occupied smaller areas.

The surface stratum, as I have already said, consists of a few feet of clay, dark grey to blackish in colour. On this there are in places sand-dunes or a thin layer of wind-driven sand just lightly covering it, where incidentally grow acacia trees, and where corn and cotton and other crops are planted. On the black clay nothing is grown but a dry-season corn called Maskwa (*Andropogon cernuum*). Below this clay is a bed of sand, which in many places is reddish. This lower bed of sand is, so far as can be judged from wells and other excavations, only about a fathom deep. Below it lies a clay of a light grey colour, which becomes nearly white on exposure, and can be used as a whitewash for walls. Its depth is not known, for the wells only penetrate so far as is necessary to reach the water-bearing level within it, and I did not meet a well that had passed through and beyond it.

If this deep deposit could be laid open, it would, I think I may venture to say, be found to contain buried rocky ridges and peaks of granite rock, both grey and red, such as one meets lower down on the road from Yola on the Benue river and before one debouches on the Bornu plain. On leaving the mountains to the south the outcrops become lower and lower until they disappear into the ground, which thenceforward is destitute of rock or stone of any kind.

At Kukawa this clay, where it was used in part to build the old outer walls of the city, is a mass of small shells. I could distinguish two species only, one a long spiral, and the other a bivalve with the halves fairly capacious. The former average three-fourths of an inch in length, the latter half an inch. Both of these shells I saw also in fair quantities on the sand close to the lake. In the clay of the region south of Maidugari, however, I did not notice them; but this may have been due to the only

clay seen by me being that which had been brought to the surface in digging wells, so it was not in great quantities. Had the shells been as plentiful as in the clay at Kukawa I do not think I could have failed to see them. Wherever this whitish clay is found, therefore, there must some part of Lake Chad have extended at some remote period of time.*

A great deal has been written to prove an ancient connection between Lake Chad and the Nile; but Tilho's surveys of the intermediate ground have shown clearly the impossibility of such a connection within, geologically speaking, modern times. What there was in the earliest ages of the world, when all the land masses were different, is another matter. The papyrus reed, which is one of the plants on which connection with the Nile is based, is common in the Congo basin; and the headwaters of the Shari river are not remote from the northern tributaries of the Congo. Further, Lake Chad is almost in water communication with the Benue river. In a very wet season I believe the water communication is actually complete by way of the Logone swamps. It would only require a very slight change of level of that land area for all the Logone water to be turned into the Benue, and possibly the waters of the Shari also. In such a case there would be no Lake Chad. With the headwaters of the affluents of Lake Chad reaching almost to the headwaters of the tributaries of the Congo, and also approaching those of the Nile, though many be now dry, a common distribution of vegetation, shells, and fish is not difficult to effect.

Desiccation.

That there is a zone of desiccation advancing south from the Sahara desert into the fertile belt is obvious. I think that there will not be found a single native agriculturist in the immediately threatened area who will deny it. Yet I believe there are a few European writers who assert that it is impossible, and that even the fertile belt is encroaching on the Sahara. I found the increasing dryness complained of while I was still far south of Bornu, and the general result of my observations is that the danger is well founded, and the most alarming feature about it is the appalling rapidity of its advance.

Mr. E. Bovill's article on the "Encroachment of the Sahara on the Sudan," which appeared in the African Society's *Journal*, 1921, is a most valuable compilation of facts on this subject, chiefly in regard to Nigeria.

* The two clays have been examined by Dr. G. T. Prior, F.R.S., of the British Museum (Natural History). He says, "The white consists mainly of small quartz grains with very little argillaceous material. The black has more clay, but also contains quartz grains. The black colour is due to organic matter, as it disappears on ignition."

I had assumed that the white clay near the lake was the same as that which I had obtained near Maidugari, but after examination of a minute portion adhering to some shells, Dr. Prior reports, "It is somewhat similar to the former, but contains rather more argillaceous material with the quartz grains. A few diatoms are present which do not appear in the other." This specimen was from Kukawa.—F. M.

I am not, however, concerned with going over his ground again, but with stating the result of my own observations and deductions within the area I passed through.

Judging by the answers to my inquiries, for the last three-quarters of a century at the very least, that is since Barth's time, there has been a steady growth of the desiccated area. The desiccation has indeed been going on from Roman times, and undoubtedly from yet earlier times. Whether there have been periods of acceleration or retardation cannot now be ascertained in regard to past centuries. What is fairly sure is that the acceleration has been recently very great. "This began in Rabeh's time," that is between 1894 and 1900, is the dating of the commencement of a dry period by the inhabitants of places where I made particular inquiries. If acceleration and retardation be denied, and a uniform advance be insisted on, then the general advance has been of a truly appalling swiftness.

It is the Sahara desert moving south. It may be held up for a time, but a temporary increase of rainfall, such as there may be in a single rainy season, can do little to resist its progress, when a previous dry year has completely destroyed the vegetation. Nature cannot recuperate itself so rapidly, and with a succeeding failure of the rain the advance goes on yet more swiftly. Two dry years do damage that a dozen wet years cannot restore.

A glance at the map of Africa will show that Lake Chad stands out like a salient into the dry zone. It forms an ample protection to the fertile land behind it, which has some of the best corn-growing properties of any land in the world. The corn, Maskwa, needs no rain. It is planted out in the vast "firki" swamps as soon as the accumulated rain-water has subsided, and the corn grows rapidly without the further help of a rainfall. All this fertile land depends on the protection of Lake Chad, and Lake Chad depends on its receiving a sufficiency of water from its tributaries, the Shari first, and the Yobe secondly.

The greater part of the basin of the Yobe falls within the limits of the area subject to rapid desiccation, and as this goes on it may be reckoned that with an ever-decreasing period of weeks in the year for pouring water into Lake Chad, the time will come when, like the Bahr el Ghazal, it will cease to pour in any at all. Hence there will be a greatly reduced lake, the area of which will depend solely on the water brought down by the Shari river. Owing to the sources of the Shari being at a safe distance to the southward, this could continue even after desert conditions had established themselves all round the lake. As the process continued the Shari would recede up its own course.

There are five ways of testing the advance of desiccation: (1) rivers drying up; (2) ponds and swamps drying up; (3) depth of wells and their abandonment; (4) nature of the forest trees; (5) southerly movement of the agricultural population, their place being taken by pastoral people.

Of the completely dried-up streams which used to flow into Lake Chad, the Bahr el Ghazal has been the one that has caused the greatest controversy. The point that has been most discussed is whether it was an affluent or an effluent. In venturing into the discussion I can only do so on the grounds of having seen what I consider an analogous case elsewhere, and the view I take is that remotely it was an affluent and later became a partial effluent.

It was by origin an affluent at the time when the mountains of Borku to the north-east were timbered and fertile, and a collecting area for water. This was probably before the historical period in Africa. As the desiccation of this hill region advanced, so the water in the Bahr el Ghazal would decrease. At that same period there would have been more water in Lake Chad than at the present day, and its area would have been greater in proportion, since the other rivers then also flowing in that more humid age would all have helped to bring in more water to the central depression. The annual rise and fall of the lake would also possibly have been greater than now; but in this connection it must not be overlooked that the rise due to the southern rivers would not coincide with the rise due to the northern affluents. They would neutralize each other as is the case on the Congo river, where there are two high and two low waters in each year. Still, in the case of Lake Chad the neutralization would have been to a much smaller extent, for the southern supply of water was assuredly in excess of what the Bahr el Ghazal and a few other smaller affluents could bring in. This excess of southern water, coming at the season when the Bahr el Ghazal would be lowest, would cause a banking up of the lake water into the lower part of the channel of the Bahr el Ghazal.

A similar thing can be seen at the present day at the confluence of the Benue with the Niger. I observed it personally in 1898 and 1899. The Benue, drawing its water principally from the south, and its sources being nearer the confluence than the sources of the Niger, begins to rise first at the confluence, and in the month of May banks up the Niger even to the extent of making a reverse current for a few days until the Niger rise makes itself perceptible. If the Niger were beginning to dry up, and the water coming down to be appreciably less, which is indeed the case, the increasing influence of the Benue, which every year would advance yet a little farther up the Niger's course, would be to make an increasing deposit of silt and raise the bed of the Niger near the confluence.

This is apparently what has occurred at the lower part of the Bahr el Ghazal. The annual rises of water of Lake Chad have raised the level of that river's bed for some distance from the mouth, and the process has continued until now the bed of the river within the reach of the lake is higher than that portion which the lake water has never attained to. It thus comes about that the present appearance of the lower part of the river is that of an outlet.

Now as to the river Yobe: I travelled close to this stream for the greater part of its course. At the end of April 1922, when I was at Yo near its mouth, there was no water flowing, but the sand had only to be scraped for the water to be found close to the surface. The width of the river at Yo is about 40 yards, and it runs between banks of sand. At Katagum and Hadeija, each on a separate tributary or branch, some 250 miles up by road but possibly over twice as far if the river itself be followed, the two affluents which join some miles below are both larger than the river at its mouth. There is no material change of latitude. It must therefore be assumed that there is a great loss of water on the way down to the mouth. Another feature is that although at these two points, Katagum and Hadeija, on the upper rivers, the water was not flowing in May, nor was it flowing at its mouth, yet at Gaidam about halfway down was continuous water, the deep pools being connected with flowing water. This may be accounted for by a change in the gradient for a short distance, for at a couple of miles below Gaidam it ceased, and a day's march higher up the big pools in the river-bed were unconnected at the surface.

Between Yo and Gaidam a feature of the river Yobe is the large number of lagoons alongside it containing standing water when the river itself is empty. They are all narrow, and some are miles long. They seem to be abandoned sections of the river, the stream having made a new channel. In flood-time they are connected with the river, and they then obtain their supply of water which lasts all through the dry season, and makes pleasant oases of them with green pasture for the flocks and herds. That they were once filled with running water is borne out by the high scarped bank one sees alternately on either side, and by their windings, where now there is no running water. They have been long separated from the main river in all probability, for no local person I met had any remembrance of any of them ever being part of the main stream, nor any tradition of the fact.

I have already mentioned the Komadugu Gana, from the south, which has not flowed in its lower course nor joined the Yobe for a quarter of a century; and the northern affluents have not flowed since time immemorial.

Turning now to lakes and ponds other than those close to the Yobe, one hears of many that have dried up completely and are now strewn with the bones of dead hippopotami. Barely two days north of Gaidam there are depressions where salt is now made. Less than twenty years ago they were pleasant lakes, and the older inhabitants remember when there were hippopotami in them.

With regard to wells drying up, I have read of this being so in some places, but not a single case came to my personal notice, nor did I hear of any from native sources. The abandonment of a well when I did meet with such a case seemed always due to the sides having fallen in, or in the case of a surface well to its having been defiled. In the latter case

no doubt it might later when needed be cleansed. I formed the opinion of the very deep wells that they are independent of local climatic conditions. Whenever I inquired as to whether a particular well had more water in it after the rainy season, I was always informed it made no difference, but I gathered that all wells after a few months' disuse in the rainy season, when there was surface water available, invariably required cleaning before coming into use again.

Then with regard to forest growth, though in other parts of Africa I have seen the eating up of the forest and its place being taken by vegetation of different species more suited to the new conditions, I observed none of this on my route. It is true I frequently came across belts or for the most part patches of forest growth of a totally different nature from the surrounding vegetation. They might stand out as islands, but there was nothing to indicate that their presence was due to changed climatic conditions. It seemed rather due to difference of soil.

In a number of places, however, near the river Yobe, I saw hundreds of dead trees, many of large size, standing in what had been swamp land, while trees around, equally species of acacia, had survived. The reason of their survival was that they grew on sandy soil slightly raised above the swamp. It might be supposed that the trees in the swamp land would have survived the process of desiccation longer than the trees growing on sand. What, however, had occurred was that in a certain year the swamp had failed to receive its customary supply of water which alone would ensure complete saturation. In the ensuing dry season the mud became so hard that the rootlets of the trees were unable to function, whereas those in lighter soil, though subject to an equal shortage of water, nevertheless managed to retain some vestige of life till the rain came again.

It is, I might add, not only by rain or underground water that the trees in these semi-desert regions live. As soon as the south-west wind is felt in the month of May, and the dry parching desert wind ceases for an increasing number of hours in the day, then the trees begin to sprout, and have put on their leaves long before the rain comes. It seemed to me also that the trees in swamp land yielded much later in many cases to the reviving influence of the moist winds, due no doubt to the excessive hardness of the mud they grow in.

I do not propose here to go into the question of tribal movements started by desiccation of the land, but would merely state that whenever a movement takes place, and a new village is founded, it is always to the south of its predecessor. I found one exception in the case of a village which had been a few miles south of the river Yobe. It had moved north to a new site nearer the river, which is of course intelligible, and still confirms the theory of desiccation.

If we take the capitals of the Bornu empire dating from six centuries back, each successive capital has been south of its predecessor. The

inhabitants of Bornu proper do not go to Kanem on the north side of Lake Chad in order to settle there. On the contrary the Kanembu have moved south, and occupy most of the towns in whole or in part as far to the southward as Ngornu. Further, the Margi, who used to extend as far north as Maidugari, the present capital of Bornu, are now only met with three or four days to the southward.

All the evidence is that the trend of migration, not only along the Lake edge, but farther west also, is in general in a southerly direction. No community goes in a northerly direction, but many movements have followed the course of the Yobe river, which gives them a westerly direction with only a slight degree of southing, since that river has held them to the fertile lands along its course.

DARFUR

E. G. Sarsfield-Hall, B.L., LL.B., Sudan Civil Service

DARFUR, or the country of the Furs, was formerly one of a chain of ancient kingdoms which stretched across the African continent from east to west, and of which Abyssinia alone survives to-day as an independent state. Its original inhabitants were a Negro race, who lived a primitive existence in the more mountainous parts of the country, and were ruled by a line of pagan Dagu sultans. In the sixteenth century, however, they were brought into touch with Mohammedan influence, and thereafter gradually converted to Islam. With their conversion, the sultanate passed into the hands of the arabicised Kungara branch of the Fur, and in 1596 Solong, the first Mohammedan sultan of Darfur, whose mother was an Arab, ascended the throne.

The old Dagu sultans had been content to rule a circumscribed area surrounding their mountain fastnesses, but their successors had more ambitious ideas and soon set about extending their dominion. Descending from the great Marra range, they not only conquered the wide plains adjoining it, but also overran the neighbouring province of Kordofan, and finally penetrated victoriously as far as the Nile. Their triumph was however short-lived, and the warlike Fungs soon commenced to drive them westwards whence they had come. By 1770 they had lost even the province of Kordofan, and, though they retook it a few years later, it was finally conquered from them in 1822 by Mohammed Bey Daftardar on behalf of the Egyptian Government.

After this reverse the Darfurians retired westwards, but fifty-two years later Darfur itself was annexed to Egypt by the famous Zubeir Pasha, who advanced into it from the south on the pretext that the Darfur sultan was unable to control his people and prevent them raiding into the Bahr-el-Ghazal. In 1877 General Gordon visited Darfur, where Sultan Harun

was in revolt, and Suliman, the son of Zubeir Pasha, was carrying out extensive slave raids at the head of a large body of well-armed followers. He sueceeded, to a certain extent, in restoring the confidence of the Government troops and in pacifying the country, but was compelled to return to Khartoum, leaving Sultan Harun still at large and Suliman but temporarily submissive.

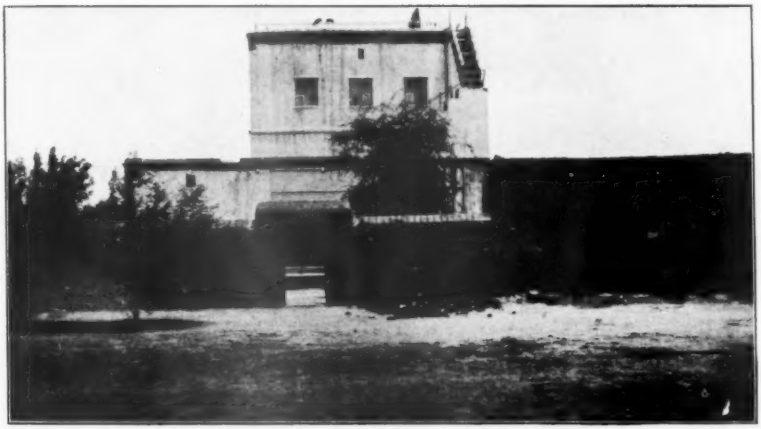
The Fur sultans hotly resented the annexation of their country by the Egyptians, to whom they refused submission, and against whom they carried on a desultory warfare from their strongholds in Jebel Marra. Whenever a sultan was slain another arose in his place, with the result that the Egyptians never succeeded in completely pacifying the country. In 1882 the Mahdists overran Darfur, and two years later their representative, the Amir Mohammed Khalid (Zogal), succeeded in capturing Abdullahi Dud Banga, the last of the sultans to defy the Egyptian Government. Peace reigned until Mohammed Khalid, being summoned by the Khalifa to Omdurman, appointed Yusef, the son of the late Sultan Ibrahim Garad, to rule Darfur during his absence. No sooner was his back turned than Yusef raised the standard of revolt, and though he himself was killed in 1888, a small but resolute hand of Furs continued to defy the Khalifa's authority. In 1896, however, Ali Dinar, the last of the rebel sultans, finding himself deserted by the greater part of his followers, surrendered to the Dervish Amir Abd el Gadir Wad Dalil. He was sent to Omdurman, and remained there until the eve of the battle of Omdurman, when he fled westwards, intending to seize the throne of Darfur. One Ibrahim Ali, a nephew of the late Sultan Yusef, had already been despatched to Fasher by Sir Herbert Kitchener with instructions to take over the administration of Darfur on behalf of the Government. Ali Dinar however reached Darfur before him, and lost no time in disposing of the Dervish Amir in charge of the province, of another rival claimant to the throne whom he mockingly appointed sultan of the despised blacksmiths, and finally of Ibrahim Ali himself.

A short time later, having securely installed himself, he acknowledged the suzerainty of the Sudan Government, and in 1900 was appointed Governor-General of Darfur, subject to the payment of a nominal tribute of L.E.500 per annum. This tribute was regularly paid until after the outbreak of the European war in 1914, when Ali Dinar cast off his allegiance and refused to make any further payments. He had, as he well knew, chosen an embarrassing time to declare his independence. Turkey had just entered the war, and the Sultan of Turkey, as Khalif of Islam, had called his co-religionists to a world-wide jehad.

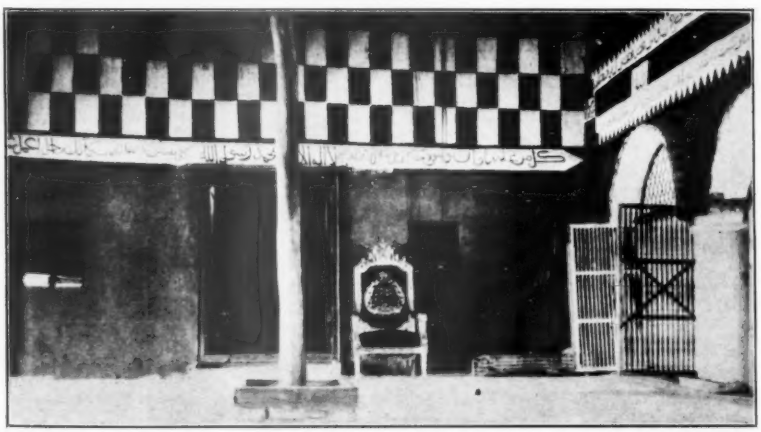
Undesirous of provoking an armed conflict, the Sudan Government used every endeavour to bring the recalcitrant sultan to reason. But Ali Dinar turned a deaf ear to all counsels, and it soon became apparent that nothing but the occupation of his country would reduce him to submission.

When the revolt was crushed the Sudan Government was faced, in

THE RAHAD—RAIN-WATER LAKE—AT EL FASHER, SEEN FROM THE SOUTH



PALACE OF THE LATE SULTAN, EL FASHER



THE WOMEN'S QUARTERS IN THE PALACE OF THE LATE SULTAN, EL FASHER

RAIN POOL NEAR NYALA, SOUTHERN DARFUR

GIRLS DRAWING WATER FROM A TEBELDI TREE

the midst of the embarrassments of the European war, with the problem of bringing a newly acquired country, approximately 160,000 miles in area, under administrative control. The whole country lies between 2000 and 3000 feet above sea-level, and down the centre of it zigzags a chain of rocky hills, sometimes assuming the proportion of mountains, which form the watershed of the country and part of the great watershed separating the Nile from the basin of Lake Chad. The geological formation of these hills is varied, and has not yet been subjected to expert examination. The Jebel Meidob group appears to contain both sandstone and granite, but has been much distorted by volcanic action. Many of the hills comprising it are the craters of extinct volcanoes, and much of the country immediately surrounding it is littered with calcined rock and lava. It consists for the most part of a conglomeration of low tangled hills, but the highest peak in the central range rises to a height of about 1200 feet above the plain.

The most interesting feature of the group are the wells at Malha in the south-west corner. Here there is a small lake, heavily impregnated with natron, situated at the bottom of the crater of an extinct volcano. It lies about 300 feet below the lip of the crater, and can only be approached by one precipitous zigzag path, and its waters are unfit for human consumption. Round the edge of the lake, however, there are numerous springs containing a copious supply of crystal-clear water. Unfortunately these springs are infested with leeches, and for this reason all water has to be carefully examined before being used by human beings. It is no uncommon sight to see blood streaming from the mouths of animals after drinking, and to find leeches adhering to their gums. These leeches are said to have been in great demand by the full-blooded Egyptian officials of the old Government, who used them for bleeding.

The Jebel Tagabo group consists of a collection of sharp rugged granite and sandstone peaks, the highest of which are about 2000 feet above the plain. Granite appears to predominate in the other groups, which all run into one another and are much distorted by volcanic agency. The highest peak of the Jebel Furnug group is Jebel Mutarrag, which is 5440 feet above sea-level and stands 1500 feet above the plain, whilst Jebel Nurnya in the Jebel Marra group, rising to a height of about 9000 feet, is the highest peak in Darfur.

To the north the country is so arid and the rains so meagre that the water draining eastwards towards the Wadi el Malik soon sinks into the sandy soil and disappears. Similarly the water in the wadis further south which run in an easterly direction appears generally to disappear into the soil, though those wadis which run in a southerly direction generally discharge water into the Bahr el Arab river. To the west and south-west the general trend of the water is into the Shari river, which empties into the southern end of lake Chad. In the north the country is alternately stony and sandy, for the most part covered with light bush, and intersected

by wadis which, being often well timbered, afford good grazing for camels.

The rainfall is generally meagre, but if sufficient rain falls grass springs up, which affords excellent pasture. When possible, grain is cultivated on the open undulating sandy tracts and a little cotton of poor quality in the depressed beds of the wadis. The rainfall, however, is so scanty, the soil so poor, and the inhabitants such indifferent cultivators, that many of them are forced either to live on grass seed or to purchase grain from their more favoured brethren in the south. During the rainy season and for a short time afterwards water is often to be found by digging shallow wells or *tumuds* in the sandy beds of the wadis. Such wells however soon run dry, and the people are then driven to water at a limited number of permanent sources which vary greatly in depth and are in many cases far apart.

The greater part of northern Darfur appears to be gradually drying up, and there is little doubt that it was at one time much more densely populated than it is at present, but that its former inhabitants were forced to evacuate it in large numbers owing to a diminution in the annual rainfall and a consequent lack of water. Ruins of extensive settlements, and hills showing traces of having been ridged for cultivation, are met with in abundance, not infrequently in regions where wells no longer exist and where the scantiness and uncertainty of the annual rainfall almost precludes cultivation. Half a century ago, for example, at Sayah, two days north of Fasher, water was found in abundance a few inches beneath the surface of the sandy wadi bed, and there were numerous well-cultivated gardens containing many thousand palm trees. Here the water has now receded to a depth of 18 feet, gardens have gone out of cultivation, and only two solitary palm trees survive. Similarly the water supply has failed altogether at Kobbe, once a great trade centre and the capital of Darfur, where water was formerly so plentiful that every merchant was said to have had his own private well inside his compound.

It is the same tale in many other parts of northern Darfur. Water is gradually disappearing, and has in some cases entirely disappeared from places where half a century ago it was found in abundance. Its disappearance appears to be primarily caused by a diminution in the annual rainfall, but it seems that it must also be due in some cases to some mysterious underground leakage or displacement, which I am unable to explain.

The eastern region of Darfur is even more waterless than the northern, and there are but twelve permanent wells in an area of approximately 20,000 square miles. Here the people and their animals are dependent for water to a large extent on a species of water-melon (*Handal*), or on supplies of water which they store during the rainy season in the hollow trunks of Tebeldi (Baobab) trees (*Adansonia digitata*). The stem of these is hollow by nature, and the hollow it contains can easily be enlarged into

a cavity of considerable capacity. During the rains water is hauled up from a reservoir dug at the base of the tree in which it collects, and poured into the hollow stem through a hole cut near the top of the main bole, and as soon as the tree is filled it is sealed up. When water is required for use it is drawn up out of the hollow stem with a skin bucket. In a sandy region where there are no wells, Tebeldi trees are of great value. They grow to a great age, and in some cases have been known to hold as much as 3000 gallons of water.

The western and southern regions of Darfur are much better watered and more fertile than the northern and eastern regions, as the rainfall is heavier, and in the south sand gives place to cotton soil. Here grain is produced in considerable quantities, and excellent wheat is grown on the terraced (ridged) sides of the hills in the Jebel Marra area. Simsim, cotton, tobacco, cucumbers, pumpkins, and melons are also grown.

The inhabitants of Darfur have been classified by Mr. Harold MacMichael, of the Sudan Civil Service, into five main groups: (1) the Arabs; (2) the Tibbu or northern Negroid peoples; (3) the sedentary indigenous races; (4) the immigrants from the west; (5) the immigrants from the north. "It appears," he states, "that in the fourteenth century large numbers of Arabs pushed westwards from the Nile after the dissolution of the Christian kingdom of Dongola, some of whom eventually became the progenitors of the camel-owning nomads of northern, and the Baggara or cattle-owning Arabs of southern, Darfur. The camel-owners of the north, roaming over sparsely populated country, naturally retained the purity of their Arab blood to a greater extent than their more sedentary brethren in the south, though all preserve their free and independent Arab spirit." The former are chiefly represented by the Mahamid, Nawaiba, Maharia, Ereigat, and Zayadia, and the latter by the Rizeigat, Habania, Taaisha, Beni Helba, and Beni Khuzam tribes. In the north the majority of the Arabs are still purely nomadic and continue to wander about, settling temporarily where the best grazing is to be found. Some of them however are in the transition stage and have settled villages, round which they cultivate and in which they sometimes remain the whole year round if circumstances permit.

The Tibbu or northern Negroid people are chiefly represented by the Meidobis in the north-east, and by the great tribe of the Zaghawa (closely allied to the Guraan and Bedayat of the Ennedi highlands) in the northern and north-eastern portions of the country. .

The Meidobis, who inhabit the Jebel Meidob group of hills, are probably a fusion of Hamitic, Negro, and Barabra stock, and speak a language which bears strong affinities to that spoken by the Barabra people of Dongola province. They are a peaceable semi-nomadic folk, whose principal wealth is in sheep and goats, and they cultivate but little. During the dry season they remain in or about their hills; but in the rains they scatter with their flocks over the wide uninhabited area east

of Jebel Meidob where grass is plentiful. They are poor builders and inhabit rough beehive-shaped huts of no permanent value, which are not tied together and properly thatched but consist of little more than boughs set in a circle and bent towards the centre, with grass thrown over them. Like their neighbours the Zaghawa, they are accomplished and incorrigible thieves, and though they profess Mohammedanism they still perform certain pagan rites, and many of them are surprisingly ignorant of the tenets of Islam.

The Zaghawa are a wild, dark, quarrelsome, thieving people, who speak a language of their own and were never under what might be called proper administrative control during the time of the late sultan. They are poor cultivators, but own large numbers of cattle, sheep, and goats. Their permanent villages generally consist of round stone-walled huts with conical thatched roofs, but they are constantly forced to abandon them for long periods owing to a lack of water and grazing, consequent on a failure of the annual rainfall. The diminution of the annual rainfall in recent years has resulted in their making a general movement towards the south, where conditions are more favourable and life easier to support. Owing to their independence and their proclivities for thieving and quarrelling, they are anything but *personæ gratæ* outside their own country, and a difficult people to administer.

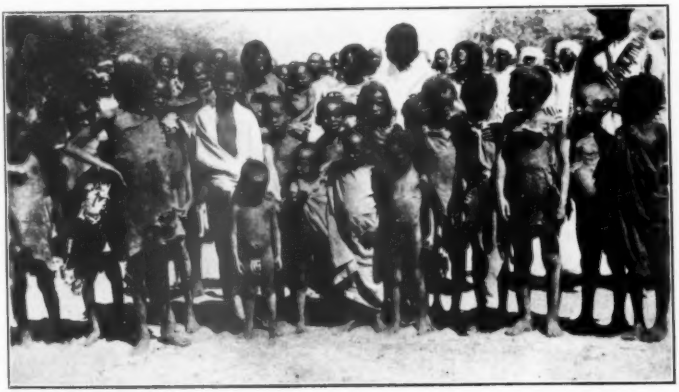
The Bedayat, well described as an exaggerated and wilder form of Zaghawa, chiefly inhabit the Ennedi highlands in the French sphere, but also exist in small numbers throughout the northern portion of the Zaghawa country. They speak the same dialect as the Zaghawa, were pagans until comparatively recent years, and in spite of their present pretentions to Mohammedanism, still perform rites in connection with certain sacred trees and rocks. They are purely nomadic and hardly ever cultivate, but subsist principally on milk and grass seed.

The sedentary indigenous races of Darfur are represented by the Fur, Berti, Birgid, Beigo, Masalit, Dadinga, and Turug peoples. Of these the two former are by far the most numerous. The Fur proper are chiefly to be found in the Jebel Marra area or west of it, but also inhabit the Jebel Si, Jebel Fornug, and Jebel Forog hills. They speak a variety of dialects, and are divided into numerous sub-sections, many of them being in a low state of civilization. The Tamurka and Jebala sections, who inhabit the Jebel Marra group, are probably the most savage and uncivilized people in Darfur, and regarded by their own Kungara brethren as slaves. Generally speaking the Fur proper, though good cultivators, are an indolent drunken folk, who have a greater reputation for treachery than for courage.

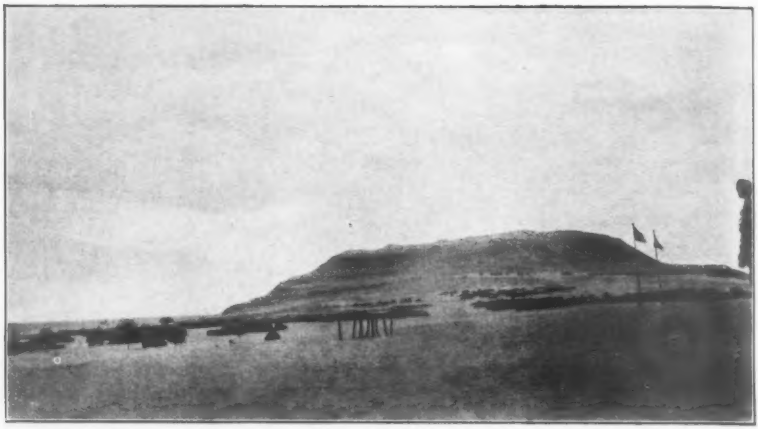
The Berti people inhabit the region lying between Fasher, the Zaghawa country, Jebel Meidob, and the Kordofan boundary, extending as far south as the region of Taweisha. They are peaceable, unenterprising folk, who have a dialect of their own, but speak Arabic and affect an

CHIEFS OF THE GURAAN TRIBE WHO SUBMITTED AT FURAWIR

POLITICAL OFFICER INTERROGATING BEDAYAT



KIDNAPPED BERTI CHILDREN RECOVERED FROM MOHAMMED ERBEIMI



JEBEL EL HILLA BETWEEN NAHUD AND UM KEDADA, DARFUR FRONTIER

CHARACTERISTIC VIEW IN NORTHERN DARFUR

MILLET NEAR ABIAD, EASTERN DARFUR

Arab descent, though they are, according to Mr. MacMichael, in all probability a mixture of Fur, Arab, and Zaghawa.

The Birgid, Beigo, Dagu, Masalit, Dadinga, and Turug peoples are primarily of Negro stock, and live permanently south-east and south-west of Jebel Marra. They are sedentary people, who profess Mohammedanism but retain many pagan rites and customs. The Birgid are good iron-workers, and the Masalit are said to be redoubtable fighters. The immigrants from the west are represented by the Fellata (Takarir) and Borgu and Mima people, and those from the north by the Kenin (or Tawarek) and Fezzan (or Magharba).

The fact that Darfur was inhabited by such a conglomeration of different peoples enhanced the difficulties of bringing it under administrative control. Each tribe had its peculiar tribal organization, and often its peculiar customs, and in some instances its own peculiar language. Some tribes had owed firm allegiance to the late Sultan Ali Dinar, whilst others had openly defied him or never been under proper administrative control. At the beginning lack of staff made it necessary to leave administration to a great extent in the hands of the untried tribal chiefs; but in order to restrict tribal feuds and prevent oppression it was necessary without delay to acquire an understanding of tribal history, tribal customs, and tribal organization.

For some time after the fall of Fasher the country was administered from headquarters with the assistance of a selected number of chiefs and notables, who had held prominent positions in Fasher under the late sultan. To commence with, only two British administrative officials could be spared for service in Darfur, but these were eventually joined by two others, and towards the close of 1916 it was found possible to commence decentralized administration by forming an eastern administrative district with headquarters at Um Keddada, about 90 miles east of Fasher, on the Fasher–El Obeid road.

After the fall of Fasher the wild Zaghawa of northern Darfur indulged in a veritable orgy of raiding and lawlessness. Armed parties moved about the country, literally seeking whom they could devour, numerous people were killed and much stock looted and driven off. In addition to these internal disorders, one Mohammed Erbeimi, a redoubtable Guraan outlaw from the French sphere, raided the northern region, looting much stock, causing loss of life, and carrying off a number of women and children into slavery. This man had been carrying on what might be almost called a guerilla warfare against the French authorities for some years, and they were meditating operations against him, in which they solicited co-operation.

Until Sultan Ali Dinar and the remnants of his army had been disposed of, no mobile troops were available; but on 18 December 1916 a camel corps column left Fasher for northern Darfur, with the object of bringing the country under administrative control and of assisting the

French authorities in putting an end to the activities of Mohammed Erbeimi. This column, which was under the command of Lieut.-Colonel T. B. Vandeleur (Royal Irish Regiment), was accompanied by the writer as Political and Intelligence Officer. With the assistance of a map made from hearsay in Fasher, it operated for over three months in a practically unmapped and largely unknown region where watercourses were few and far between and supplies difficult if not impossible to obtain. It succeeded in establishing the authority of the Government in northern Darfur and in recovering and restoring nearly two thousand head of stock which had been looted in internal raids after the fall of Fasher. Though the patrol failed to get in touch with Mohammed Erbeimi, it captured some of his leading men and recovered a number of women and children captured by him. Furthermore, it prevented him breaking away to the south and east, and thus enabled the French forces to inflict a severe defeat on him, which disintegrated his band and resulted in his surrender to the writer a year later.

During the course of the operations of the patrol a wheel and compass traverse of the route taken was made by Mr. A. A. R. Boyce, of the Sudan Survey Department. This traverse was adjusted and corrected by periodic observations for latitude, and supplemented by plane-table and compass triangulation, as opportunity offered. It formed a valuable skeleton survey of the region, on to which, pending an accurate triangulation, elaborating wheel and compass sketches could be tied.

In April 1917 a District headquarters was established at Kuttum, 70 miles north-north-west of Fasher, and a few months later a subsidiary police-post under a native officer at Um Burro, 90 miles north of Kuttum in the Zaghawa country. The inhabitants of the northern region were thus brought in touch with the Government and under control. Early in 1917 a District headquarters was established at Nyala in southern Darfur, with a subsidiary police-post at Abu Gabra in the Rizeigat country, and a commencement was made to bring the southern region under administrative control. Owing to the exigencies of the Great War, it was impossible to provide a staff for the administration of western Darfur, but to maintain order a military post was established at Zalingei, west of Jebel Marra. The whole of Darfur, with the exception of the sultanates on the western marches, temporarily in the hands of the French, was thus by the end of 1917 brought under effective Government control.

The old capital of Darfur was Kobbe, a great trade centre and the southern terminus of the famous caravan route to Egypt known as the Arbain Road (so called from the fact that it took forty (Arabin) days to travel it). At the end of the seventeenth century El Fasher was adopted as the capital, and has since remained the chief town, whilst Kobbe has ceased to exist, owing to the failure of its water supply. El Fasher is a large native settlement consisting chiefly of well-constructed conical huts, enclosed in grass fences, which are built on either side of a wide

depression running north and south. During the rains this depression, fed by a khor, fills with water and becomes a lake, whilst in the dry season water is drawn from numerous wells sunk in the bed of it, from which gardens are also irrigated.

Crowning the western slope, and standing inside a spacious compound crammed with a profusion of lesser buildings, is the palace of the late sultan Ali Dinar, now the residence of the Governor. It consists of a pretentious two-storied whitewashed building, ornamented with texts from the Koran which are painted round it in coloured friezes, and having inlaid doors and windows and a rail of glittering tin around its topmost roof. Near it stand the women's quarters, the chief feature of which is a beautifully constructed chamber with a thatched roof and terracotta and white interior walls covered with texts from the Koran. The ends of this chamber are closed by two rooms, one square and the other round, whilst its side walls consist of arches filled with meshrabia work giving on to deep verandas. The royal buildings as a whole display remarkable craftsmanship and taste, and have been not inaptly described as a Sudanese Alhambra. Apart from them, the only other buildings of note in Fasher are the mosque, a few residences belonging to odd members of the sultan's family, and the dazzling white tomb of Zacharia, the father of the late sultan. Fasher is now an important trade centre with a population of probably 14,000, but in the event of it being found impossible to link it up by railway, it may be found necessary to move the capital further south.

There are at present no other towns in Darfur, and Dara, which in the time of Slatin Pasha was the administrative headquarters of the Province, is now deserted, owing to the failure of its water supply.

It is difficult to form an estimate as to the value of Darfur as an acquisition. Up to date the Government has been able to pay little attention to the development of the country, and it will take its inhabitants time to recover from the results and depredations of the late régime. The country as a whole is well suited for stock-raising. Good cattle, sheep, and goats are bred, the best cattle in the south, and the best sheep and goats in the Zaghawa country. Horses are also reared, but though hardy, they are generally of a poorish quality and lacking in bone. Excellent animals are however sometimes found in Dars Rizeigat, Masalit, and Gimr, and much could probably be done to improve the breed. The northern Arabs breed camels, and their herds have shown a marked increase during the last few years.

Shortly after the occupation of Darfur a considerable export trade in cattle, sheep, goats, and skins was developed with Kordofan, the animals exported being partly home-grown and partly imported from the west. This export trade shows great possibilities of further development. It will however be necessary, so far as Darfur is concerned, to induce owners to sell more readily than they do at present; to take compre-

hensive measures for dealing with outbreaks of cattle sickness, which is endemic in various forms; to increase the supply of water in certain areas by making new wells or preferably, if possible, by sinking artesian bores; and to facilitate export by constructing a railway to Darfur, or by building storage tanks or sinking artesian bores along the Fasher–El Obeid road, as its present lack of water prevents the export of animals in any numbers over it except during the rainy seasons.

Excellent crops are grown in southern Darfur, but nature's bounty has had a demoralizing effect on the inhabitants, who are indolent and intemperate, and suffer from the effects of never having had to work hard for a living. If the region was brought into touch with external markets and a demand for its products thus created, it would and could undoubtedly produce vastly more grain, cotton, simsin, and tobacco than it does at present.

It has been so far impossible to make a geological survey of Darfur, but it seems not unlikely that such a survey when made will result in the discovery of mineral deposits. Iron is extensively found, copper workings exist at Hofrat-el-Nihas (lit. copper-holes) on the south-east boundary, and lead deposits at Kuttum in the north. To work deposits in most parts of the country it would probably be necessary to tap artesian water, and to make such working pay it would be necessary to supply cheap through transport to the sea.

Darfur at present suffers the severe handicap of being cut off from the rest of the Sudan. Its primary and most important need is connection by rail with El Obeid and the Sudan railway system. The main trade route from Kordofan to West Africa passes through El Obeid and Fasher, and it would therefore be desirable in many ways that any railway built should follow it. Unfortunately it traverses an ill-watered undulating tract of sandy country unsuitable for railway construction, and over which a railway could only be constructed at enormous expense. It thus seems likely that a railway when built will not follow the El Obeid–Fasher route, but run south of it, taking a line over more level and better-watered country where sand gives way to cotton soil. In this case it will enter Darfur a considerable distance south of Fasher, which will probably in course of time cease to be the centre of gravity of the Province.

The whole future development of Darfur depends upon its connection by rail with the outside world, but there are at present other projects in the Sudan which seem to offer a better immediate return to capital than a Darfur railway would yield, and so it seems probable that the construction of such a railway will be deferred for some years to come. Though Darfur may not in the mean time pay its way, its inhabitants will increase in understanding and prosperity year by year, so that when they are eventually brought into touch with outside markets they will probably make a more immediate response to the opportunities thus offered them than they would at present.

REVIEWS

EUROPE

Frequented Ways.— Marion I. Newbigin, D.Sc. London: Constable. 1922. *With Illustrations from Photographs, Sketch-maps, and Figures.* Pp. xii. + 321. 15*s*.

In 'Frequented Ways' Miss Newbigin has given us a remarkable and characteristic bit of work. It is a general survey of the land forms, the climate, and the vegetation of Western Europe, considered specially in relation to Man, and is thus specifically geographical; and though she definitely states that it is not intended for the geographer proper, but for the intelligent traveller, there is no question that it is precisely to the former that it will make most—and irresistible—appeal. It is divided into two parts, the first dealing with the general characteristics of the West European lands, the second with some of the typical regions. The relations between the two are largely those existing between principles and their application, but no hard and fast line is drawn or even suggested; Part I. contains chapters on primæval forest, myrtle and bay, moor and heath, and Part II. contains chapters on uplands, hills and valleys, snow and ice.

The whole makes an admirable and effective revelation of the unique variety of the small West European area, and therefore of its unique interest to students of geography. As Miss Newbigin points out, we in these islands have, within a few hours' journey, access to many of the most fascinating geographical phenomena, *e.g.* fiords and young folded mountains, glaciers and active volcanoes. A citizen of Montreal must cross his continent to find some of these, and a citizen of Melbourne must go altogether outside his continent to find any of them—that is to say any of the four specified. Moreover, in Western Europe the natural lines of least resistance are so arranged that we can see this unique variety almost without diverging from the artificial lines of movement.

The book was written, and apparently in type, before the war—incidentally a distinct advantage (except, no doubt, to the publisher), and so its outlook is essentially normal, while the treatment is essentially novel. It is a scientific study of scenery in the strictest *geographical* sense, made with wide and deep knowledge, and based on close personal familiarity with the features and phenomena described and analyzed. Indeed, almost the only unconvincing thing about the book is its title; for it is so obviously the *un*frequented ways, and even the untrodden spot, that really appeal to the author. And in a sense this adds to its value to the geography student. Our environment nowadays in Western Europe is so patently man-made, and Prof. Brunhes is so persuasive about "the chief geographical agent," that the other aspect of the whole truth is somewhat obscured or neglected. The ferries, the bridges, the tunnels, of New York suggest to the average person the skill of the human engineer far more than the *increased* control exercised by the Hudson over New York.

We have a few complaints to make; but they are very few, and are concerned with very minor points, some of them only personal whims, *e.g.* a detestation of the misused possessive in such monstrosities as "France's pride," and some intolerance of the constant repetition of the phrase "and so forth." There are one or two statements which one would challenge, *e.g.* the over-emphasis of the importance of relief in viti-culture in Lombardy (p. 146). We doubt, too, whether the author realizes how many travellers are seeking only sheer rest

and relaxation, and that they would find her book not easy reading, even though ultimately it would greatly increase their enjoyment of the scenery when they find their bearings.

On the other hand, we are intensely grateful for the charming descriptions —many of them illustrated beautifully by the author and her sister—the vivid novelty, the unfailing stimulus of the book, regarding it purely from the personal point of view. After thirty years of lecturing on the area, and much time and trouble spent in trying to study it from all possible aspects, with special interest in the ground covered by many of the chapters, one finds in every case—without exception—new facts, suggestions, and interpretations. And, while not pretending for a moment to agree with all, one can think of no book so helpful and stimulating to students in the Geography Honours Schools of our Universities. Indeed, the width and depth of knowledge behind such work is literally immense ; and the results are presented with such taste and skill that the book is not only a mine of information, but also a source of continuous fascination by the added interest and the surprising novelty which it gives to familiar and frequented ways. L. W. L.

The Western Question in Greece and Turkey.— Arnold J. Toynbee. London : Constable & Co. 1922. Pp. xvi. + 420. *Maps.* 18*s.* 6*d. net.*

This is clearly one of the most important books dealing with the Near East. It is written by an expert historian, a man with imagination and sympathy, some knowledge of Greeks and Turks, and of European politics in general, and a most persistent desire to be impartial (and, what is very remarkable, impartial not only between Greece and Turkey, but between the Near East and Western Europe). It is therefore the more depressing to find much of its history fantastic, and its political conclusions more than doubtful. Fortunately this *Journal* is not, as such, concerned with history or politics ; fortunately, for the geographical and descriptive sections of Professor Toynbee's book are the best. There has not been written a clearer or more convincing statement of the difficulties of the Greek military position in Anatolia—those difficulties, that is, that were due to the physical character of the country—than his sixth chapter, "The Military Stalemate" ; though it is difficult to see why he chose the word "stalemate" to describe a position in which all the advantages were on one side, as events have proved. Excellent too are his descriptions of parts of the country in "A Journey through the Mountains" and "The Battle of In Önü." Geographers will find matter of permanent value in this ; as will historians in the account which the author gives of the country and its people, and of its administration by Greece. In this account the author is always most careful to distinguish between what he knows at first hand, and what he only heard of from others ; and as he has a very graphic pen, this part of the book will form a most valuable document for the history of Western Asia Minor during this particular period. The logical weakness of the book lies in the fact that, though he is thus minutely careful to distinguish what he saw himself from what he did not see, but only heard or read of, and though he is so anxious to be impartial and fair and to understand things, and in general succeeds in this, his conclusions are most of them based on a comparison between what he saw (which impressed him and will impress his readers) and what he did not see (which has little power of impressing anybody), that is between Greek and Turkish misdeeds. But that belongs to politics. The three maps are only perfunctory sketches, which serve the purpose of the book, but will not be of use to geographers. A. W. G.

ASIA

The Andaman Islands: A Study in Social Anthropology (Anthony Wilkin Studentship Research, 1906).— A. R. Brown, M.A., formerly Fellow of Trinity College, Cambridge. University Press, 1922. *Illustrations.* 40*s. net.*

This handsome and excellently illustrated volume by a Cambridge research scholar of considerable standing should be the last word on this long-studied and fast disappearing people, about which much that is excellent has already been written; for Mr. A. R. Brown has had great opportunities, first-rate previous research to go upon, and a visit of about a year's duration to the islands themselves, under favourable conditions for observation. But he has spoilt his book by too much reliance on his own powers and too little consideration for the efforts of his predecessors. He adversely criticizes most of them and is specially unfair to Mr. E. H. Man, whose observations have rightly been long held in high estimation for care and accuracy, though Mr. Brown constantly quotes them, almost always to belittle or controvert, on a comparatively quite small experience. He is hard on the others whom he quotes, and disagrees often in cases where they are much the more likely to be right—at any rate where they had better opportunities for observing. This is a great pity, for he is obviously an able and painstaking student of anthropology well trained to his science, and he might have produced a classic on his subject, whereas all he has succeeded in doing in the first part of his book is to produce evidence which can be usefully taken into consideration, if it be understood that it does not supersede that of Mr. Man and other competent predecessors.

In the evidence he produces, however, there is one very important item which is quite new—the peace-making ceremony of the North Andaman tribes, which has never been previously reported. Mr. Brown goes into this point at length, and is entitled to all the credit there is in the discovery. But to my mind he has marred his book throughout: firstly, by adopting the "Anthropos alphabet" of Pater Schmidt for recording the language of the Andamanese in place of the long-established and now well-known alphabet drawn up half a century ago for the purpose by the late Mr. A. J. Ellis, F.R.S., in his last Presidential Address to the Philological Society. This has served to create confusion in the lay mind as to the forms of Andamanese words. Secondly, he has adopted the vicious plan of calling each tribe by its own name for itself instead of by the long-recognized forms taken from the language best known to European observers. The result is as confusing as if we were to talk in English books of the Français, the Belges, the Deutsch, etc., whenever we speak of the French, the Belgians, the Germans, or other nationalities.

But it would be entirely unfair to Mr. Brown to base an account of his book on the first part only, as in the second and far more important part he has elaborated a new anthropological theory with great skill, acumen, and care, based on his observations of the Andamanese as primitive savages. Here we have Mr. Brown at his best. Very briefly, the theory he has worked out is that the explanation of ideas and customs of any given primitive people must be sought in human nature itself, *i.e.* in the natural working of the human mind and not in comparing them with the ideas and customs of other people in an assumed similar mental condition. It is "natural" explanation *versus* "comparative" explanation. The idea is as revolutionary as regards anthropology as it well can be, and Mr. Brown has obviously felt that he must justify himself. He has honestly tried to do so with all his cards on the table. Whatever may be the outcome of the criticisms to which his theory must of necessity be subjected

he has put up a good case and argued it with such ability that anthropologists will be obliged to take it into serious consideration. There is no fault to be found with this aspect of the book, whether the theory be eventually shown to be sound or unsound. It goes against the grain to be unable to say as much for the rest of it. R. C. T.

AFRICA

Carte Géologique Provisoire du Maroc (1920).— Louis Gentil. 1/1,500,000. 1 sheet, 24 inches × 21 inches. Paris: Larose. 1920.

At the meetings of the Société Géologique de France northern Morocco now takes the place held forty years ago by the Scottish Highlands at the London Geological Society. Controversy rages over its tectonics, and the final interpretation is probably the same as in the latter case. Prof. Gentil at least has no hesitation in marking off a large area as one of great overthrust rock-sheets (*nappes de recouvrement*), and unless his opponents can disprove the accuracy of his mapping no other interpretation seems possible; for in the pre-Rifian region north and east of Fez he shows us "windows" where Miocene appears from under Eocene, while Mesozoic strata are strangely wedged between them. These and other effects of powerful horizontal thrusts from the Mediterranean are limited by a line which touches Meknes and Fez at its southernmost and curves on the one side sharply to the N.W., on the other to the E.N.E. North of this boundary the tectonic lines are a continuation of those of the Betic Cordillera of Spain. To the south we have the Atlas and anti-Atlas, where there are no thrusts but many very long fault-lines with a general E.N.E.–W.S.W. trend. A striking feature here is the great volcano of Jebel Sirowa.

To distinguish between unexplored areas the geology of which is matter of inference and those actually surveyed, the former are over-printed with thin red lines: this device has the advantage of not distracting the eye when taking a broad view of the structure. Equally inconspicuous distinctions are made between boundaries actually surveyed and those surmised, while a further distinction is reserved for "abnormal contacts" of overthrust masses. Economic interest is given to the map by a special indication of the phosphate-bearing areas of the Cretaceous. Altogether the map is very carefully designed, and it embodies the result of much arduous work on the part of Prof. Gentil and other French geologists—at times highly adventurous work, for we understand that some of the mapping could only be carried on during temporary military occupation of hostile areas. A. M. D.

The Wonderland of the Eastern Congo: the Region of the Snow-crowned Volcanoes, the Pygmies, the Giant Gorilla and the Okapi.— T. Alexander Barns. With an Introduction by Sir H. H. Johnston. London and New York: G. P. Putnam's Sons [1922.] *Illustrations.* 31*s.* 6*d. net.*

Mr. Alexander Barns' book is of the type we are most wanting now. The first pioneering of the world has nearly all been accomplished, and in the tracks of the original path-finders are following men with more leisure to describe the countries they pass through. Mr. Barns went through very little country that was not already known in its bare outlines. We were aware of the existence of the lakes and rivers and mountains he saw. But he went armed with a photographic battery, butterfly nets, and insect-killing bottles; and, what was better, he was possessed of an eye which could observe, so he was able to bring back a picture of the natural scenery and the human, animal, and insect life of the regions he and his intrepid wife passed through on their long journey from

Katanga, across Lake Tanganyika, through the rich Ruanda country, by the beautiful Lake Kivu, on to the wonderful volcanoes of Niragongo and Murwura, across Lake Edward, up Ruwenzori, and then through great forests to the Congo, and so on to the sea again.

It was in the main a collecting expedition. Through the interest of Mr. Joicey in collecting lepidoptera for the Hill Museum at Witley, Mr. Barns was provided with the necessary funds for the expedition, and we as well as Mr. Barns may be grateful to Mr. Joicey for furnishing the means of doing such good work. But a perusal of the book gives the impression that Mr. Barns was keener at heart on shooting big game than on catching butterflies. And he is evidently one of those who really loves the great animals and the wild regions in which they are found. The buffalo is a noble animal whom he admires more than he admires most men. The lion is suspected of the unpleasant trait of eating his own offspring at times; but the lioness is always affectionate to her cubs. He was not successful in shooting the rare and timid okapi. But he did secure one just as it had been killed by a leopard, and he was more fortunate with the gorilla, for at considerable risk he shot a magnificent specimen and was able to observe the haunts and habits of this rare animal. Elephants also he shot. And he collected 760 distinct forms of butterflies and more than 250 species of moths—of which 78 forms of butterflies and 57 of moths are new to science. This was a good bag, and he also saw, but was unable to capture, a magnificent great bird butterfly flying across the Congo. In addition he made most interesting observations of the character and habits of the peoples he met, who varied from the inhabitants of Ruanda over 7 feet in height to the pygmies of the Ituri forest only 4 feet 2 inches high.

Mr. and Mrs. Barns must have worked with the greatest assiduity to produce such results. It is evident that they truly felt the call of the wild, and they answered to it with all their heart. The result is a living book which carries the reader along, enables him to see the game-haunted plains, the lovely lakes, the mighty Congo, the gloomy forests, and makes him wish to follow in their footsteps.

The book also suggests that Europeans actually settled in the various districts through which the travellers passed might in their leisure moments take advantage of the peculiar opportunity they enjoy to describe their district in a few of its many aspects, so that we at home might have a true picture of it and enjoy some few of its delights. F. E. Y.

AUSTRALSIA AND PACIFIC ISLANDS

The Conquest of New Zealand Alps.— Samuel Turner. London: T. Fisher Unwin. 1922. *Illustrations.* 21*s. net.*

"So I was determined to live up to the world's newspapers' belief in me and not allow any climber (guide or amateur) to belittle my reputation from that standpoint" (p. 157).

Mr. Turner's ideal is strenuous, and fortunately for his book he does not invariably remember to live up to it. There are moments when he seems more interested in mountains and wild country than in what the world's newspapers may be saying about him; moreover these moments probably occur with greater frequency than he is aware of.

To judge from this account of the New Zealand Alps the mountaineering there seems to be in a dangerous phase; the safe routes have not yet been thoroughly worked out, and in spite of the heavier snowfall causing more

frequent avalanches than in Europe, the dashing school of colonial climbers seems inclined to underestimate this danger. There is a tendency, too, to indulge in more hairbreadth escapes than are healthy for wise mountaineers who love their craft. The account on p. 149 of the ascent of a 1000-feet crack "more formidable looking than the Grepon" is startling. It would be interesting to have the opinions of other climbers as to whether snow and ice lie at steeper angles than in Europe.

The habit of taking another man up to huts, not as a climbing companion but as a witness to certify the genuineness of the author's solitary ascents of peaks, is an undesirable innovation apparently originated by Mr. Turner. He says what he can in favour of solitary ascents, but there seems to be no reason why so sincere a mountain lover as Mr. Turner should need the tremendous stimulus of solitary mountaineering to whip up his enthusiasm.

The author is a gallant climber but a busy man, and these hastily compiled notes suffer from the want of a map. The statement on p. 28 that "the summit of Mount Cook this year is quite 250 feet higher than six years ago" is presumably due to a slip of the pen.

POLAR REGIONS

Amid Snowy Wastes.— Seton Gordon. London: Cassell & Co. 1922. Pp. 206. *Illustrations and Maps.* 15*s. net.*

Mr. Seton Gordon spent a month of early summer in Spitsbergen with a party of Oxford naturalists who visited the archipelago in 1921. Even if his experience of Spitsbergen was not extensive, he made the best use of his time, visiting Ice Fjord, Prince Charles Foreland, Liefde Bay, Moffen Island, and Cloven Cliff. As his main object was to study bird life more time on the west coast, especially the Foreland, would not have been amiss. In various likely places in Ice Fjord and elsewhere he searched for the ptarmigan, and is puzzled at his failure to find it. But this bird is always local and spasmodic in its appearance in Spitsbergen. A favoured locality may be deserted in any year. The ptarmigan hides extraordinarily well and escapes detection, though we can scarcely suppose it evaded Mr. Gordon's experienced eyes. Its numbers are certainly decreasing year by year, for it is easily approached and killed, but in places it is still to be found. Of the mammalian fauna except seals Mr. Gordon has little to say, because he scarcely touched its haunts. The larger forms of wild life have been almost exterminated in the easily accessible regions of the west. The book aims to deal only with the natural history of Spitsbergen, and though brief it is readable and full of information. A few mistakes however occur. Prince Charles Foreland is not under eternal snow as Mr. Gordon suggests; for at least two months all the lower ground is normally snow free. The pack off the south-west coast comes mainly from the north-east of Spitsbergen past the Wyche Islands. Storfjord gives a very small if any contribution. The cold current at Bear Island comes from the east of the Barents Sea and not from Storfjord. Among the pack encountered late in June it is doubtful if pancake ice would occur; it was more probably brash ice and snow. The Cape Thordsen peninsula is not Dixon but Dickson Land; the name commemorates the great Swedish patron of polar work, Oscar Dickson. The folding map is apparently taken from an Admiralty chart, not of the latest date, with certain additions. It would have been better to take the outline from the more correct Norwegian chart. There are mistakes in several of the names, and the old fiction of inland ice makes several appearances in the map, though it is repudiated in the text. The book is well illustrated with over 100 photographs. R. N. R. B.

GENERAL

Terrestrial and Celestial Globes, their History and Construction.— E. L. Stevenson, Ph.D., LL.D. Newhaven: published for the Hispanic Society of America by the Yale University Press. [London: Humphrey Milford.] 1921. *Price* 50*s. net.*

In these two octavo volumes of some 450 pages of letterpress and 143 figures, mostly on separate plates, we have at last a work that is worthy to be entitled a History of Terrestrial and Celestial Globes. Dr. Stevenson has gone far to fill this gap in geographical literature, for although we have had most excellent studies of certain phases of the subject, as for instance Sir Clements Markham's introduction to his Hues' *Tractatus de Globis* and Ravenstein on Martin Behaim and his 'Erdapfel,' yet no one had previously attempted a comprehensive history of globes in the English language. It is obvious that the author's principal interests are centred in a globe as a whole, in its maker, and in its owner. He discusses problems of construction, problems relating to the nature of the materials used, and to the appropriate application of globe-gores. Less space is devoted to the critical consideration of the historical interest of the stages by which the early faulty representations of land and sea were gradually rectified. Perhaps the small size of the figures, while sufficient to recall the appearance of the globes, was insufficient to illustrate a discussion of geographical detail.

The historically important globes in Italian institutions had already been surveyed by Prof. Matteo Fiorini, and of his collected material the freest use has been made. It has thus doubtless come about that of the 850 examples listed by the author, next to the globes now in the United States, a larger proportion of globes are enumerated from Italy than from any other country. There must surely be many others in Spain, and the fact that only one English globe is figured and that very few are mentioned, leaves us with the suspicion that the author has not carried his studies very far into this country. For instance, when stating that five globes by Senex have been located, he appears not to know that there are at least seven by that maker in Oxford alone; and he makes no reference to Senex's predecessor, Price, whose globe is in the Museum of the Royal Geographical Society. It would seem gratuitous to suggest that no copy of J. Russel's moon-globe is in existence, when there is one here in the Radcliffe Observatory. In these and in many other details Dr. Stevenson has shown how difficult it must be for any one who lives in the New World to do adequate justice to the culture of the Old World, yet, in these days of costly printing, we are much indebted to him for his book with its bibliographic notes and long indexes of globes and their makers, and to the Hispanic Society of America for undertaking the publication.

In the modern curriculum the educational value of an understanding of the Use of the Globes has been entirely lost to sight, yet formerly such an exercise was esteemed one of the most valuable of juvenile studies. In illustration of this, we are glad to be reminded of the recorded experience of a child of poor parents, unspoilt by a modern "education," who afterwards became famous. James Ferguson "made a globe in three weeks, turning the ball thereof out of a piece of wood." On this he delineated the map of the world, and found to his great pleasure "that by using the globe, which was the first that I ever saw, I could solve the problems in Gordon's Geographical Grammar."

Although we have ventured to point out certain omissions in the record of existing globes here supplied, we are none the less grateful to the author for the large amount of useful information brought together by him, which must have

entailed industry and perseverance of no mean order. The work will form the basis for any further study of the history of globe-making for many years to come. R. T. G.

Alpine Ski-ing at all heights and seasons.— **A. Lunn.** London: Methuen & Co. 1921. Pp. 116. *Illustrations and Diagrams.* *5s. net.*

The Alpine Ski Guides. The Bernese Oberland.— Published on behalf of the Federal Council of British Ski Clubs by Messrs. King & Hutchings, Uxbridge. 1920. Vol. **2.** Pp. xxviii. + 170.

The first of these volumes aims to impart a thorough knowledge of ski-ing, and is addressed mainly to those who have some experience in the use of ski. The author pays much attention to what he terms snowcraft, rightly believing that the ski-runner who takes an interest in the nature of the snow and the effects on it of atmospheric condition will double his enjoyment and reduce to a minimum the risk of accidents. The chapters on snowcraft and avalanches are good, but while Mr. Lunn is a sure guide on the effect of the föhn on snow surfaces he will need to revise his explanation of the föhn given on p. 64. A chapter on Arctic ski-ing would add to the interest of the book.

The second volume consists of itineraries for ski-runners between the Gemmi and the Grimsel. The tours are arranged in geographical sequence.

R. N. R. B.

14,000 Miles through the Air.— **Sir Ross Smith, K.B.E., M.C., D.F.C.** London: Macmillan & Co. 1922. Pp. 136. *Illustrations and a Map.* *10s. 6d. net.*

With his brother, Sir Keith Smith, as navigator, and Sergeants Bennett and Shiers as mechanics, Sir Ross Smith won the prize of £10,000 offered by the Commonwealth Government for the first flight to Australia in not more than 30 days. This is now old history in the story of flying, the feat being accomplished at the end of 1919, and the gallant pilot has met his end in the more adventurous undertaking of a flight round the world. But he made history by the flight to Australia, and gained an immortal name. Darwin, in Northern Australia, was reached in 27 days 20 hours after the departure from Hounslow. Of this period only 135 hours had been spent in actual flying. The length of the daily flight was determined by the position of the aerodromes, and these naturally enough come in for most attention in the book. The Dutch authorities very kindly constructed several new aerodromes in the East Indies, with the result that the airmen seldom had to fly more than 500 to 600 miles at a stretch. The two longest flights, each 700 miles, both fell between Bandar Abbas and Delhi. One of the most difficult flights, and incidentally the most thrilling in the tale, was that from London to Lyons, a great part of which was above the clouds, in intense cold. The descent to Lyons through a gulf in the cloud, some 2 miles wide and 7000 feet deep, was a dramatic return to the world. Another exciting and difficult flight was through the clouds over Burma on the way to Bangkok. On the whole, however, the flight went smoothly, and the Vickers-Vimy machine behaved splendidly. The chief difficulties occurred in rising from some of the small aerodromes. Numerous aerial and other photographs illustrate the book, which, in spite of its unassuming style, must be regarded as a classic of air travel.

R. N. R. B.

THE MONTHLY RECORD

EUROPE

Underground Water-supply of Cambridgeshire, Huntingdon, and Rutland.

THIS subject is dealt with by Mr. Whitaker, who had previously done the same service for various other counties, in a recently published *Memoir* of the Geological Survey. Although no attempt is made to bring out in detail the lessons in economic geography (such as the relation between water-supply and the distribution of population) which might be learnt from the data put forward, the study is of considerable general interest, apart from the practical application. Within the three counties water is chiefly got by means of wells, though a certain amount comes from springs. The town of Cambridge was once supplied from chalk springs, but these have long been supplanted by wells. Both Huntingdon and St. Neots depend solely on a supply from shallow works draining a tract of river gravel. Apart from a quite recent boring near Ramsey, the wells or borings reach a depth of 400 feet in only four cases, and it is remarkable that the deepest of these—at Whittlesford (455 feet)—is wholly in drift. Surface supply for public purposes (from river-water) is hardly met with anywhere. The water-bearing beds in the three counties are various gravels of the Drift ; the Chalk and Lower Greensand ; and various calcareous and sandy beds of the Oolites and Lias. The first-named source is of some importance in Huntingdonshire, but the advantage offered by permeability is offset by their liability to pollution. The Chalk gives a supply in Cambridgeshire only (of the three counties dealt with), and as the slope of the escarpment is here more gradual than usual, so that an unusually broad tract intervenes between the top of the escarpment and the boundary-line of the Chalk, it is from the Middle and Lower Chalk that the water is got, and not from the Upper division, as is more usually the case. Mr. Whitaker goes fully into the position of the water-table in the Chalk, which almost always rises beneath high ground. The generally constant relation of the water-table to the valleys is sometimes interfered with by the dip of the beds, such an abnormal relation being well seen in the Gog Magog Hills, where a synclinal dip depresses the water-plane by throwing out the splendid springs which once supplied Cambridge. In no county has the Lower Greensand been so thoroughly exploited for water as in Cambridgeshire, Cambridge itself getting a supplementary supply from this source, while Ely seems once to have got its water from a well in this formation. Still it falls distinctly behind the Chalk in importance. Springs in Cambridgeshire are chiefly from the Lower Chalk, some thrown out at or near its base, others from the Totternhoe Stone, a bed which marks the top of its lowest member. A long line of springs from the latter has determined the sites of many villages. Among the most copious springs are those at Great Shelford, Cherry Hinton, Melbourn, and Shepreth, the last two yielding a supply of 4 million gallons daily. The question of pollution is fully discussed, and in the latter part of the memoir the chief spring and well supplies are tabulated.

The Power Resources of Ireland.

Inquiries into sources of power, whether derived from fuel or falling water, are being made on all hands, and nowhere perhaps was such a study more needed than in Ireland, which has depended in the past very largely on imported coal, apart from the utilization of peat for domestic purposes. The present position has lately been reviewed by Mr. George Fletcher in a paper read before the Royal Society of Arts in May last, and printed in that Society's

Journal for July 14. In 1917 the peat question was dealt with by a Committee of Inquiry, with Sir John Griffith as chairman, and in 1919 the Irish Coal Industry Committee studied the question of coal reserves, subsequently dealt with more fully by a Commission of Inquiry appointed by Dail Eireann (cf. *Journal*, vol. 59, p. 60). In 1918 an Irish sub-Committee of the Water-power Resources Committee of the Board of Trade was appointed, once more with Sir John Griffith as chairman, and has collected valuable data, so that fuller information is already available on all three heads. Ireland is unfavourably placed as regards coal, though by including the Munster coalfield, remote and offering considerable transport difficulties, with its estimated reserves of 1,570,000,000 tons, the total reserves were swelled by the Dail Eireann Commission to over 2,000,000,000 tons as against about 228,000,000 arrived at by the Coal Industry Committee. At present Ireland does not raise more than one-fiftieth of the coal consumed in the country, and though the proportion might no doubt be increased, Irish coal will probably find serious rivals in peat and water-power. The reserves of peat are enormous, and experiments have already pointed to possible improvements in methods of peat utilization, whereby the difficulties arising from its high water-content, great bulk in proportion to calorific properties, and friability, seem in a way to be overcome, in part at least. It has been shown that by suitable maceration a more uniform product is secured, and one which both dries more quickly and is of improved density and texture. It is proposed to combine the peat-winning with the reclamation and cultivation of the bog surface and also the cut-away surface. As regards water-power, that available on four of the larger rivers has been studied by engineers who have submitted reports. In drawing up schemes for its utilization importance has been attached to the avoidance of diversions of rivers, three or four smaller power stations, each with its own barrage, being recommended in place of a single one of greater capacity involving the great cost of a long head-race. Natural storage reservoirs exist in the loughs on the courses of three of the rivers, and for the fourth, the Liffey, it is proposed to create an artificial lake by a barrage across the gorge at Poulaphouca. The Liffey scheme is of interest because of its neighbourhood to the Dublin industrial centre. Altogether it is estimated that half a million water horse-power is continuously available in Ireland. Besides being used in the towns for the creation of new industries, cheap electrical power would be an undoubted boon to agriculture.

The Drought of 1921 in the British Isles.

A joint paper on this subject by C. E. P. Brooks and J. Glasspoole appears in the *Quarterly Journal of the Royal Meteorological Society* for April 1922, the latter author presenting the facts of the drought as experienced in the British Isles, and the former discussing the attendant meteorological conditions. The dry period of 1921, which was most intense in June, began in February and ended in November, though there was a well-marked prelude in the autumn of 1920. It appears that, taking the whole area of the British Isles, the year 1921, which had only 80 per cent. of the average rainfall, was less dry than the record year 1887 with only 77 per cent., but that taking England and Wales alone the respective figures are 71 and 74. In the south, indeed, the total rainfall for the year was less than 60 per cent. of the average (less than 50 in the east of Kent), and was the smallest ever recorded since the inauguration of reliable records, while from less trustworthy evidence there are indications that there has been no such dry year for at least a century and a half. In London the total fall of 13 inches was in defect of the evaporation by some 5 inches, a

unique occurrence in this climate, the nearest approach being in 1893, when the rainfall only exceeded the evaporation by 1½ inch. It is clear that England in the summer of 1921 was included in a great drought region embracing the greater part of Europe, and since the south-eastern portions of the country received only about 50 per cent. of a none too large average the economic results were very severe. On the other hand, in Scotland and Ireland the deficiency was only about 20 per cent. on a much higher annual average, so that in the north and west there was no drought in the real sense, at all events for more than short spells at a time during the course of the year. In the Western Highlands of Scotland the year had actually a slight excess. Attention is drawn by the authors to the interesting fact that in keeping with a more continental climate the variations of rainfall from the average are more excessive in England than in Scotland and Ireland.

Mr. Brooks goes on to show that the dry conditions were accompanied by atmospheric pressure much in excess of the average, and he endeavours to discuss the physical basis of certain admittedly unreliable periodic tendencies to drought which may yet offer a fertile field of inquiry in connection with the prevision of disastrous droughts. But the real problem is to explain why, once in every ten years or so, the Mediterranean high-pressure area expands northwards to such an extent that the polar edge of the south-westerly winds where the barometric depressions form lies too far north to bring rain to the south of England, which consequently experiences an obstinate summer drought similar in type, if not in intensity, to that of 1921. Shorter-period droughts in this country are commonly associated with the east winds of the spring months, the most remarkable instance being the lengthy spring drought of 1893.

It seems desirable to point out that though the summer of 1921 was unprecedently dry it was not so hot as that of 1911. Thus at Greenwich there were 45 days in 1911 on which the air temperature exceeded 80° F., including 7 above 90° with one reading of 100°, whereas both in 1893 and 1921, the other two outstanding summers of the last half-century, the number was only 29, with 4 above 90°. But in 1893 the 80° readings began in April, and in 1921 lingered far into October, after which there was a rapid decline of temperature to the level of severe winter cold in November.

ASIA

The Date Industry in 'Irak.

A most informing report on 'Dates and Date Cultivation of the 'Iraq,' by V. H. W. Dowson, has been issued as Memoir III. of the Agricultural Directorate, Ministry of Interior, Mesopotamia (Cambridge: W. Heffer & Sons, 1921). In Dr. Theobald Fischer's monograph on the Date-palm, issued in 1881 as a supplementary number of *Petermanns Mitteilungen*, geographers have long been provided with an excellent guide to the history, distribution, and physical conditions of date cultivation in general, but this could naturally not enter into extensive details as regards conditions in special regions, and these are now admirably supplied for a region which is second to none as a date-producing area. The date-palm as a rule matures its fruit only in a rainless land of intense and prolonged summer heat, rain preventing fertilization of the flowers and ripening of the fruit. On the other hand, the roots require to be liberally supplied with water, so that the habitat of the tree (as a fruit-producer) is limited to the irrigable dry belts on either side of the tropics. In 'Iraq it flourishes everywhere, if watered and attended, southward of Ana

on the Euphrates and Samara on the Tigris, but the most important area is that of the Shat al 'Arab, which is in fact the largest single area of date cultivation in the world. Both banks are lined with date-gardens for 108 miles, and the total number of palms may perhaps reach 15 or 16 million. Although not particular as to soil, the tree will only yield a good crop if the land is thoroughly cultivated, and in the Shat al 'Arab the custom is to dig the ground every fourth year to a depth of 4 feet, shallow digging being given in the other years. If subsidiary crops are grown in the date-gardens the cultivation they receive is considered sufficient for the palms. The requisite water is provided by tidal inundation, by gravitation flow, or by lift by various means from the river or wells; and the tree appears able to flourish when irrigated by very different waters—clear, silt-laden, salty, sulphurous, etc. Full information is given as to the conditions of ripening, harvesting, and propagation, the technical native terms being mentioned throughout, as well as the names of the principal varieties. In maturing, the date passes through four distinct stages, known as *Chimri*, *Khalal*, *Ratab*, and *Tamar*. The *khalal* of certain varieties is sweet and juicy, and esteemed by the Arabs. It has reached its full size, but the skin is not wrinkled. At the *ratab* stage it is too squashy to travel far, but the *ratab* of certain varieties is a great delicacy. The fully ripened *tamar* form the dried dates of the market. Dates exported from Basra are of four main kinds, going chiefly to the United Kingdom, India, the United States, etc., while northern Lower 'Iraq exports three main kinds to northern Arabia, Syria, and northern Persia. The total export in 1919 was estimated to reach a value of 263 lakhs of rupees, of which 111 represented the export to the United Kingdom and 73 that to India. The methods of packing are also described, and it is noteworthy that the large boxes used for the purpose (holding 68 pounds of dates) are imported from Scandinavia in pieces, being nailed together by native workmen. In 1919 the price of each box as landed at Basra was as much as $2\frac{1}{2}$ rupees. The memoir is illustrated throughout by photographs showing the stages of growth and the methods of harvesting and packing.

Sultan Kait Bey's Journey through Palestine and Syria, 1476.

We have received from the translator, Mrs. R. L. Devonshire, the copy of a French version of the Arabic narrative of this journey, written by one of the functionaries who accompanied the Sultan, Abu'l Baka ibn Djian by name. The narrative, which possesses considerable interest as throwing some light on the conditions in Palestine and Syria in the fifteenth century, is thus made available for the first time to those not acquainted with Arabic, it having been previously published in the latter language only, by its discoverer Signor R. V. Lanzone (Turin, 1878). The paper is extracted from the *Bulletin de L'Institut Français d'Archéologie Orientale*, tome xx., 1921, and is thus no doubt intended primarily for orientalists. The general reader might have welcomed somewhat more help in the way of introductory matter than is given; thus the date of the journey only transpires when the reader has reached the third page of the actual narrative, and he is then obliged to convert the date from the Mohammedan to the Christian reckoning, it being given merely as 882. Mrs. Devonshire says that it is evident that the Sultan contemplated the possibility of an Ottoman invasion, and desired to inspect the fortifications of his outlying provinces, which, in fact, he put in a better state of defence by repairs and additions. Here again the uninstructed reader would be glad to learn more about the general political conditions, as between the Mameluke Sultans of Egypt and the Turkish power which eventually overmastered them, though

the evil day was postponed until after Kait Bey's time, thanks to his victories. The publication includes photographs, mostly supplied by Captain Cresswell, of some of the ruins dating from Kait Bey's time, but unfortunately the reprint sent to us gives no key to their identification. In the task of translation Mrs. Devonshire had the advantage of help from two Arab sheikhs as well as advice from several competent savants. She supplies abundant footnotes explanatory of the text and by way of identification of the less-known places mentioned in the narrative. She also gives a sketch-map of the route, which on the outward journey led by Baalbek, Tripoli, and Laodicea to Antioch, striking thence to the Euphrates at Birejik, and returning by Aleppo, Homs, and Damascus. An extract from the historian Ibn Iyas in reference to the journey confirms the accuracy of the "Mameluke," as the writer of the main account styles himself after the fashion of the time.

AFRICA

Agriculture in the Cameroons.

Mr. F. Evans, Government Supervisor of Plantations in the Cameroons, discusses the development of agriculture in that territory, now being administered by Great Britain, in a recent number of the *Bulletin of the Imperial Institute*. It is well known that under German administration much was done to encourage plantation by private enterprise, and not only were the indigenous products such as rubber and palm oil fostered and improved, but experiments were made with other crops likely to succeed. This work is being continued under the British administration so far as means allow. A system of voluntary labour has been instituted with promising results, and there should be no special difficulty in this respect. The soil is fertile, rainfall plentiful, and general conditions favourable, so that the country is held to offer great opportunities to enterprising settlers with sufficient capital at their disposal.

The Drought Menace in South Africa.

Although much of South Africa was dry long before the white man arrived, it seems now pretty well established that as a result of his activities large tracts have been in great measure denuded of their vegetation, with disastrous effects on the water-supply, and serious losses to farmers in consequence. The danger of this state of things is coming to be widely recognized, and in 1920 the Government appointed a Commission to inquire into the best means of avoiding losses by drought. After considerable investigation in different parts of the country, it has presented an Interim Report (Government Printer, Pretoria, 2*s*.), which is summarized in the *Journal of the Department of Agriculture* for August 1922. The Commission has so far found no evidence that the average rainfall of South Africa has changed during recent historic times, though variations occur and there are good and bad years. Personal reminiscence, it is held, is misleading. But while the mean annual rainfall remains constant, its economic value has been largely reduced by an alteration of the nature of the surface for which man is responsible, the quantity of rain absorbed showing a continual decrease. The effects of drought are most severe where small stock-farming is practised, and it is from this quarter that the causes are to be sought. Chief among them is held to be the practice of kraaling the small stock at night at fixed places, principally as a protection against the depredations of the jackal. This involves much driving of stock, which is both detrimental to the animal and also leads to a destruction of the vegetable cover of the soil by trampling. The prevalent practice of over-stocking is another cause of mischief, leading to over-grazing and the destruction of the

perennial fodder-plants. The effects of drought are rendered worse by the insufficient water-supply provided on many farms and the small care taken to reserve fodder for times of scarcity. As a result of the destruction of the natural cover the country is being rapidly eroded, the whole soil of the country (a strictly limited and irreplaceable asset) being insidiously eaten away by surface erosion by wind or water, as well as by donga or sloot formation. These watercourses are gradually deepened, and branch channels eat their way into the banks, so that the surface soil is eventually removed and an increased run-off results, the water being rapidly carried to the sea instead of soaking into the ground. The recommendations of the Commission include the extermination of the jackal, the adoption of a system of paddocking whereby the driving of stock to the kraal may be obviated, the provision of cheap fencing material, and the better organization of the farming community. It is held that State control of soil erosion is a duty that should be at once undertaken. Without an early adoption of energetic measures the Commission forecasts a gloomy future for the country, which is threatened with becoming one great uninhabitable desert.

Physiography of Sierra Leone : Erratum.

In the seventh reference at the foot of page 59 of the July number of the *Journal* the author's name should have been given as J. D. Falconer, as printed correctly in the text itself.

AMERICA

Forest Fires in Montana and Idaho.

The relation of climatic conditions to the destructive fires that have always devastated the splendid forest tracts of western Montana and northern Idaho is shown in a paper by J. A. Larsen based on reports of the U.S. Forest Service for the period 1909 to 1919 published in the *Monthly Weather Review* for February 1922. Of the various causes of conflagration mentioned—lightning, railways, encampments and "slash" burning—lightning is the chief, accounting for 84 per cent. of all cases, a fact, also true for the mountains of California, which seems to indicate that electrical disturbances of a somewhat dry type predominate to a greater extent in the Western States than in Europe. The region west of the Continental Divide is stated to suffer much more from fire than that to the east, because in spite of a higher annual rainfall the summers are of the dry Pacific type, whereas on the other side a summer rainfall prevails, and an average rainfall of 2 inches per summer month is sufficient to restrict forest fires. In Idaho, on the western side, a heavy annual precipitation gives rise to luxuriant forests with much dead material, which becomes very inflammable during the dry summers when dry warm winds blow from the desert region east of the Cascades. Very bad fire seasons are those combining a lower annual with a lower summer rainfall than usual.

It is interesting to note that in Great Britain heath and forest fires assumed somewhat serious proportions during the dry summer of 1921, and that on a small scale they are always a feature of hot dry spells, particularly in the month of June, when the spring tendency for drying easterly breezes persists into the period of fierce midsummer radiation. Whilst various human agencies suggest themselves as the immediate exciting cause of such outbreaks as occur in this country, it would be interesting to know how near to the ignition point of dry combustible matter the natural temperature may sometimes rise in specially favourable locations, *e.g.* on southerly slopes catching the noonday rays perpendicularly at the high solstice.

Sir Anthony Shirley's Jamaican Raid.

Mr. Frank Cundall's brochure on 'Jamaica under the Spaniards' was noticed in the April number of last year's *Geographical Journal*, and the documentary sources from which his study of the subject was made were therein explained. At page 19 there is a brief reference to the raid perpetrated by Sir Anthony Shirley and his fellow-adventurers, in 1597, after entering the lagoon of Caguaya (Hunt's Bay, adjoining Port Royal) with his squadron of three vessels and a couple of small craft. One of Sir Anthony's shipmates in the *Bevice* committed an outline of their voyage to writing, and we owe the preservation of that narrative, albeit a somewhat sketchy one, to the insight and assiduity of good old Richard Hakluyt. The same incident has been alluded to, *en passant*, by other writers; but it is only quite recently that its details have been brought to light in an interesting article contributed by Miss Irene A. Wright, of Seville, to the *Hispanic American Historical Review* (vol. 5, No. 2, 1922). Sir Anthony's expedition had been fitted out under the patronage of the Earl of Essex with the object of plundering Madeira and the Portuguese settlement at São Thomé; but while off the African coast this destination was altered for the Cape Verde Islands, and from Porto Praya a course was steered for the West Indies in quest of spoil. Being in need of provisions, and hearing at Santa Marta that Jamaica abounded in beeves and cassava, the pilots made shift to seek out its port, where Sir Anthony requisitioned 1000 *arrobas* (about 11 tons) of meat and 30 loads of cassava meal from the Spanish colonists, who were but a poverty-stricken community lacking arms and ammunition, and only one hundred and thirty persons in all. To enforce this demand he landed an armed party of his swashbucklers twice as many in number, who, guided by a renegade Carib, marched 2 leagues into the interior to Villa de la Vega—the "Village of the Plain"—which has since developed into the Spanish Town of to-day. The pillage and burning of the little settlement by those ruthless privateersmen, their pursuit of the treasurer, the accountant, the vicar of the convent, and others (including the abbot of the island, who fled half naked into the wilds, where the fugitives were stripped of what remaining possessions they had been able to carry with them), are described in simple but moving terms in the depositions recorded before the governor by some of the sufferers after the English had left. Under cover of a report by that officer, the licentiate Don Fernando Melgarejo de Cordova (who was absent at the time of the raid), these depositions were sent home to the king, Don Felipe II., then in the last degenerate year of his life and reign; and are among the papers recently discovered in the *Archivo general de Indias* by the industry and acumen of Miss Wright, at the instance of Mr. Cundall and the Board of Governors of the Institute of Jamaica.

It is remarkable how little seems to have been known by the English at that period about the geography of Jamaica, and how few of the Spanish place-names adopted by the early colonists and explorers have survived, even that bestowed by Columbus upon the island as a whole a hundred years before Shirley's visit—"la isla de Santiago"—having given way to the Antillian designation already to be found on the Cantino and Canerio charts of 1501–2.

B. G. C.

GENERAL

Geography in London University.

An incorrect impression may have been given, inadvertently, by the note on this subject in the September number, p. 235. Special attention was called to the courses to be provided by King's College and the London School of

Economics for candidates for the Honours Degree and Diploma in Geography, simply because we understood that this marked a step in advance on the part of those sections of the University. It is within the knowledge, however, of many of our readers that a strong school of geography has been in existence at University College for a number of years, under the joint auspices of Professors Lyde and Garwood, and that full provision has there been made both for undergraduate and post-graduate teaching.

The Copper and Bronze Ages in South America.

We are asked to state that Baron E. Nordenskiöld's work with the above title, reviewed on p. 305 of the October number, is published in this country by Mr. Humphrey Milford, the price being 18*s.* 6*d. net.*

OBITUARY

Colonel E. H. Grove-Hills, C.M.G., C.B.E., F.R.S.

WE record with deep regret the death on October 2 of Colonel Edmund Grove-Hills, Royal Engineers, Secretary of the Royal Institution, Treasurer of the Royal Astronomical Society, a Fellow of our Society since 1903, and distinguished for his contributions to astrophysics, geodesy, and geography. Last May he was one of the British delegates at the Rome meeting of the Union of Geodesy and Geophysics. On his way home he represented our Society at the celebration of the Seventh Centenary of the University of Padua. Towards the end of July he was taken ill; an exploratory operation condemned him to death, and happily he did not suffer long.

While Instructor at the S.M.E., Chatham, he developed an interesting method of determining longitude in the field by photographing the moon among the stars with a floating camera; and similar ideas led many years later to his invention of the suspended photographic zenith-telescope recently installed by him at the Durham University Observatory, of which he was Honorary Director. The instrument was intended for the study of variation of latitude at different stations. Colonel Hills—to use the name by which his friends will remember him, for he assumed the name Grove-Hills quite recently—made several long journeys to observe total solar eclipses, and students of the 'Oxford Note Book' in *The Observatory* will find many amusing stories attributed to 'Colonel Rivers' which are strongly reminiscent of Hills' half-serious humour.

From Chatham he went to the War Office as Chief of the Topographical Section (now the G.S.G.S.), acted as Secretary to the Argentine–Chile Boundary Tribunal, and made a famous report on the survey of Canada. He then retired from the Service, and save for occasional special employment, as when he reported on the survey of Southern Nigeria, he devoted himself to scientific work in astronomy and geophysics, until at the outbreak of war in 1914 he went back to the Royal Engineers with the rank of Colonel, was employed throughout on the headquarters staff of the Eastern Command, and was in 1918 promoted Brigadier-General. The long strain of the war, and the loss in action of both his sons, aged him markedly; but he seemed fit for many years' more scientific work when he was suddenly struck down. The death of so learned and ingenious, so amusing and lovable a man is a sad loss to the Societies which he adorned and for which he laboured.